Balsam Lake Aquatic Plant Survey and Management Plan

Prepared for
Balsam Lake Protection and Rehabilitation District

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WASHBURN CO.

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Executive Summary

Balsam Lake's aquatic plant community is diverse, healthy, and of higher quality than the aquatic plant community of the median lake in Wisconsin. A comparison of 1999 and 2005 data indicates the lake's aquatic plant community is stable and very little change has occurred during the past 6 years. One noteworthy and positive change occurring during the past 6 years is a reduced occurrence of curlyleaf pondweed. The relative frequency of curlyleaf pondweed declined by 0.15 (i.e., 15 percent) and coverage declined by 24 percent during the 1999 through 2005 period. The results of the Balsam Lake 2005 survey indicate native vegetation has successfully competed against curlyleaf pondweed such that native species have prevented an increase in curlyleaf pondweed coverage and have displaced curlyleaf pondweed in some locations. The results of a percent similarity analysis of curlyleaf pondweed to determine the similarity of the curlyleaf pondweed community during 1999 and 2005 indicate the changes in the curlyleaf pondweed community are small. The percent similarity was 0.93, which is very close to the maximum similarity of 1 (i.e., no change occurred in the curlyleaf pondweed community). The data from the 2005 survey are good news for the lake, citizens who enjoy the lake, and the Balsam Lake Protection and Rehabilitation District, which manages the lake.

Despite the favorable aquatic plant community found in Balsam Lake, a few locations require management to attain and sustain the lake's beneficial uses. Swimming beaches, boat landings, and navigation channels require treatment by a herbicide at least once or twice each summer. Based upon treatment records during 2002 through 2005, an annual treatment area of approximately 14 acres is estimated. In addition, four areas within the lake note a plant density of 3.5 or greater (at least 70 percent of the rake head covered by vegetation. This density rating indicates these areas of the lake have problematic plant densities which interfere with recreational use of the lake and provide a less than ideal habitat for the fishery. The 4 areas cover approximately 33 acres.

The total area of the lake requiring management is estimated to be 47 acres, which is approximately 6 percent of the 770 acres of plant growth within the lake. The treatment area is approximately 2 percent of the lake's surface area (2,054 acres). Although the total area of the lake requiring management is very small in comparison to the area of the lake containing plant growth, management of this area is essential to attain and sustain the lake's beneficial uses.

The Balsam Lake management plan is comprised of an annual maintenance program and a long-term improvement program. The annual maintenance program is a nuisance relief program and long-term change is not expected from this program. The long-term improvement program is expected to result in long term change which will improve the lake's aquatic plant community. The annual maintenance program uses a common management tool, the herbicide Reward. The long-term improvement program uses a promising experimental tool, lime slurry. The annual maintenance and long-term improvement program treatment areas are shown on Figure EX-1.

Annual Maintenance Program

The annual maintenance program will sustain the lake's beneficial uses by treatment of boat landings, swimming beaches, and navigation channels each year. Inspection will occur each June and August. Treatment with 2 gallons of Reward per acre will occur when inspection results indicate treatment is warranted.

Long-Term Improvement Program

The long-term improvement program will use lime slurry to reduce plant density, including curlyleaf pondweed density, to attain favorable long-term changes in problematic areas. The problematic areas are located within areas designated by the Wisconsin Department of Natural Resources as sensitive areas for the lake's fishery. Because these areas are particularly important for the lake's fishery, management within these areas is restricted by the WDNR to protect fisheries habitat. Lime slurry is considered the appropriate management tool for these areas because it effectively reduces plant density while preserving native species and protecting fisheries habitat.

The long-term improvement program is a stepwise program consisting of small trial test areas followed by treatment of larger areas. Treatment is expected to begin in 2007. The treatment program is expected to be a part of a larger project completed by the U.S. Army Corps of Engineers. Areas within Balsam Lake intended for treatment by lime slurry include 4 areas with a plant density of 3.5 or greater. If the treatment of these 4 areas proves successful, areas within the annual treatment program (boat landings, swimming beaches, and navigation channels) will be treated with lime slurry. Evaluation of this treatment will determine whether lime slurry outperforms Reward in treatment effectiveness and whether lime slurry treatment is less costly than Reward. If lime slurry is less costly or more effective (i.e., reduces treatment frequency or results in better control), lime slurry will be used for treatment of boat landings, swimming beaches, and navigation channels in addition to areas within the long-term improvement program.

Treatment Effectiveness Monitoring Program

An evaluation program will determine the effectiveness of the annual and long-term treatment programs. Completion of an aquatic plant survey once every 5 years is recommended to evaluate the results of the annual treatment program. Because of the lake's stability and the lack of change in the aquatic plant community during the past 6 years, an evaluation once every five years is sufficient for the annual treatment program. The survey will duplicate past surveys and the data will be compared with data collected from previous surveys. If the plant community remains stable, then no change in the annual maintenance program is warranted. Changes in the plant community may necessitate changes in the annual maintenance program.

The evaluation program for the long-term monitoring program is expected to be a part of a larger U.S. Army Corps of Engineers project. Pre-treatment and post-treatment monitoring is expected to occur during each year of treatment. Monitoring details are expected to be determined by the U.S. Army Corps of Engineers and are expected to be consistent with the larger project.

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1.0 Introduction

Balsam Lake in Polk County, Wisconsin is valued by lakeshore property owners, area residents, Polk County, and the WDNR for its fisheries and for recreational use. The lake has a surface area of 2,054 acres and a maximum depth of 37 feet (See Figure 1). Its fishery is comprised of northern pike, walleye, largemouth bass, and panfish.

Historically, plant growth within portions of the lake has impaired recreational use of the lake. In 1999, the Balsam Lake Protection and Rehabilitation District completed an aquatic plant survey of the lake and an aquatic plant management (APM) plan. The aquatic plant survey results indicated the total area of plant coverage in Balsam Lake was approximately 805 acres (i.e., 41 percent of the lake's surface area). No open area was noted in the lake's littoral zone. Some areas within Balsam Lake noted a dense plant growth, either resulting from the dense growth of an individual species or a dense growth resulting from the cumulative effect of several species. Dense growths of *Ceratophyllum demersum* (Coontail) and *Nymphaea tuberosa* (White Water Lily) were noted at 6 percent and 3 percent of sample points, respectively. The concurrent growth of many species resulted in an overall plant growth density of 2.75 or greater (i.e., plants covered more than 55 percent of the rake head used for sample collection) at about one third of sample locations. Much of the littoral region of Little Balsam Lake and a portion of the Balsam Lake littoral region noted a density of 3.5 to 4.75 (i.e., plants covered 70 to 95 percent of the rake head used for sample collection) (Barr 2000).

Curlyleaf pondweed was found in 583 acres of the 805 acres of macrophyte growth in Balsam Lake. Hence, curlyleaf pondweed was found in 72 percent of the lake's aquatic plant growth area and 28 percent of the lake's surface area (Barr 2000). The data indicated that although curlyleaf pondweed growth is widespread in Balsam Lake, other species are relatively successful in competing with curlyleaf pondweed. However, areas of the lake noting the densest plant growth generally noted curlyleaf pondweed growth.

The survey results were used to develop an APM plan. The plan identified effective macrophyte management activities and recommended a phased approach to accomplish the District goals for plant management.

- Phase 1–annual treatment of swimming beaches, boat landings, and navigation channels within the lake (Primary Plan).
- Phase 2–early spring herbicide treatment of curlyleaf pondweed (CLP) in selected areas to reduce growth of this nuisance species and restore native aquatic plant species in areas currently affected by CLP (Secondary Plan).
- Phase 3–early spring herbicide treatment of CLP in remaining growth areas not treated in Phases 1 and 2.

The District has implemented Phase 1, annual treatment of navigation channels, during 2000 through 2004. In 2004, the District began implementation of Phase 2. Two areas of CLP growth were treated with the herbicide endothall (Liquid Aquathol K) during the spring of 2004 and again during the spring of 2005. The treated areas were 1.5 and 11.5 acres in size (Aquatic Engineering Inc. 2004; Aquatic Engineering Inc. 2005).

The Balsam Lake APM Plan recomended that an aquatic plant survey be completed approximately once every five years. Because five years had passed since completion of the 1999 survey, the District completed an aquatic plant survey in 2005. In addition, the 2004 Aquatic Plant Management (APM) Permit issued to the District by the Wisconsin Department of Natural Resources (WDNR) required the District to revise the Balsam Lake APM Plan before making any changes to its aquatic plant management program (May 10, 2004 Permit Letter, WDNR). This report presents the survey results and an updated aquatic plant management plan for Balsam Lake. This report discusses:

- Overview of macrophyte growth in lakes
- The methodology of the 2005 Balsam Lake aquatic plant survey
- Results and discussion of the 2005 Balsam Lake aquatic plant survey
- Comparison of 1999 and 2005 survey results
- Balsam Lake Aquatic Plant Management Plan

2.0 Overview of Macrophyte Growth in Lakes

The basis of the following text on macrophyte growth in lakes is Minnesota Department of Natural Resources (MDNR) *A Guide to Aquatic Plants Identification and Management* (1994).

2.1 Location of Aquatic Plant Growth Within Lakes and Impoundments

Within a lake, pond, or impoundment, aquatic plants grow in the area known as the littoral zone—the shallow transition zone between dry land and the open water area of the lake. The littoral zone extends from the shore to a depth of about 15 feet, depending on water clarity. The littoral zone is highly productive. The shallow water, abundant light, and nutrient-rich sediment provide ideal conditions for plant growth. Aquatic plants, in turn, provide food and habitat for many animals such as fish, frogs, birds, muskrats, turtles, insects, and snails. Protecting the littoral zone is important for the health of a lake's fish and other animal populations.

The width of the littoral zone often varies within a lake and among lakes. In places where the slope of the lake bottom is steep, the littoral area may be narrow, extending several feet from the shoreline. In contrast, if the lake is shallow and the bottom slopes gradually, the littoral area may extend hundreds of feet into the lake or may even cover it entirely. Impoundments frequently note extensive littoral areas in the upper portion due to sedimentation and shallow depths. In contrast, the lower portions of impoundments may have little littoral area.

Cloudy or stained water, which limits light penetration, may restrict plant growth. In lakes where water clarity is low all summer, aquatic plants will not grow throughout the littoral zone, but will be restricted to the shallow areas near shore.

Other physical factors also influence the distribution of plants within a lake or pond. For example, aquatic plants generally thrive in shallow, calm water protected from heavy wind, wave, or ice action. However, if the littoral area is exposed to the frequent pounding of waves, plants may be scarce. In a windy location, the bottom may be sand, gravel, or large boulders—none of which provides a good place for plants to take root. In areas where a stream or river enters a lake, plant growth can be variable. Nutrients carried by the stream may enrich the sediments and promote plant growth; or, suspended sediments may cloud the water and inhibit growth.

2.1.1 Categories of Aquatic Plants

Aquatic plants are grouped into four major categories:

- Algae have no true roots, stems, or leaves and range in size from tiny, one-celled organisms to large, multi-celled plant-like organisms, such as *Chara*. Plankton algae, which consist of free-floating microscopic plants, grow throughout both the littoral zone and the well-lit surface waters of an entire lake. Other forms of algae, including *Chara* and some stringy filamentous types (such as *Cladophora*), are common only in the littoral area.

- Submersed plants have stems and leaves that grow entirely underwater, although some may also have floating leaves. Flowers and seeds on short stems that extend above the water may also be present. Submerged plants grow from near shore to the deepest part of the littoral zone and display a wide range of plant shapes. Depending on the species, they may form a low-growing "meadow" near the lake bottom, grow with lots of open space between plant stems, or form dense stands or surface mats.

- Floating-leaf plants are often rooted in the lake bottom, but their leaves and flowers float on the water surface. Water lilies are a well-known example. Floating leaf plants typically grow in protected areas where there is little wave action.

- Emergent plants are rooted in the lake bottom, but their leaves and stems extend out of the water. Cattails, bulrushes, and other emergent plants typically grow in wetlands and along the shore, where the water is less than 4 feet deep.

2.1.2 Value of Aquatic Plants

Aquatic plants are a natural part of most lake communities and provide many benefits to fish, wildlife, and people. In lakes, life depends—directly or indirectly—on water plants. They are the primary producers in the aquatic food chain, converting the basic chemical nutrients in the water and soil into plant matter, which becomes food for all other aquatic life. Aquatic plants serve many important functions, including:

- ***Provide fish food***—More food for fish is produced in areas of aquatic vegetation than in areas where there are no plants. Insect larvae, snails, and freshwater shrimp thrive in plant beds. Sunfish eat aquatic plants besides aquatic insects and crustaceans.

- ***Offer fish shelter***—Plants provide shelter for young fish. Because bass, sunfish, and yellow perch usually nest in areas where vegetation is growing, certain areas of lakes are protected and posted by the DNR as fish spawning areas during spring and early summer. Northern pike use aquatic plants, too, by spawning in marshy and flooded areas in early spring.

- ***Improve water quality***—Certain water plants, such as rushes, can actually absorb and break down polluting chemicals.

- ***Protect shorelines and lake bottoms***—Aquatic plants, especially rushes and cattails, dampen the force of waves and help prevent shoreline erosion. Submerged aquatic plants also weaken wave action and help stabilize bottom sediment.

- ***Provide food and shelter for waterfowl***—Many submerged plants produce seeds and tubers (roots), which are eaten by waterfowl. Bulrushes, sago pondweed, and wild rice are especially important duck foods. Submerged plants also provide habitat to many insect species and other invertebrates that are, in turn, important foods for brooding hens and migrating waterfowl.

- ***Improve aesthetics***—The visual appeal of a lakeshore often includes aquatic plants, which are a natural, critical part of a lake community. Plants such as water lilies, arrowhead, and pickerelweed have flowers or leaves that many people enjoy.

- ***Provide economic value***—As a natural component of lakes, aquatic plants support the economic value of all lake activities. Wisconsin has a huge tourism industry centered on lakes and the recreation they support. Residents and tourists spend large sums of money each year to hunt, fish, camp, and watch wildlife on and around the state's lakes.

3.0 Aquatic Plant Survey Methods

An aquatic plant survey was completed in the lake during June 2005 to characterize existing conditions. The survey was completed by a Barr Engineering Company professional, with assistance from Balsam Lake volunteers. The sampling locations and sample methodology were the same as the 1999 survey to facilitate a direct comparison of the 1999 and 2005 survey results. Following is a description of the sampling methodology used for the survey.

An aquatic plant survey was completed during June 23 through 24, 2005. The sampling protocol for the June survey followed the rake sampling methodology developed by Jessen and Lound. The methodology is outlined in "Wisconsin's Department of Natural Resources Long-Term Trend Monitoring Methods," (Bureau of Water Resources Management, July 1987). This methodology enables the plant specialist an opportunity to determine the presence, frequency, and density of different plant species. The following outlines the Jessen and Lound methodology that was followed:

- A total of 23 transects were surveyed at the locations shown on Figure 2. Transects extended from the shoreline to the maximum depth of plant growth.

- The Global Positioning System (GPS) readings from the 1999 survey were used to locate and sample the same locations in 2005 that were sampled in 1999.

- Sediment type was determined at each sample location.

- Transects were broken down into the following depth categories:
  - 0 to 1.5
  - 1.5 to 5.0 feet
  - 5.0 to 10.0 feet (or to maximum rooting depth).

  - Four samples were taken at each depth zone to determine the presence and abundance of species. The sample point at each depth zone consisted of a 6-foot diameter circle divided into four quadrants. A tethered garden rake with an extended handle (16 feet) was used to collect a sample from each quadrant.

- Collection of samples, identification of species, and determination of density ratings for each species occurred at all sampling points. Density ratings were given in accordance with the following criteria:

Rake Coverage (% of Rake Head) Covered by a Species	Density Rating
81-100	5
61-80	4
41-60	3
21-40	2
1-20	1
0	0

4.0 Results and Discussion

4.1 Aquatic Plant Survey Results

4.1.1 Aquatic Plant Types

Results of the Balsam Lake aquatic plant surveys during 1999 and 2005 indicate the lake contained a diverse assemblage of aquatic plant species representing four aquatic plant types—algae, submersed plants, floating-leaf plants, and emergent plants. Of the four types, submersed plants dominated the macrophyte community in both years. Table 1 summarizes 2005 survey results and compares these results with 1999 survey results.

Table 1. Macrophyte Type Distribution

Aquatic Plant Type	% of Sample Locations	
	1999	2005
Chara (alga)	22	17
Submersed Aquatic Plants	100	100
Floating Aquatic Plants	83	65
Emergent Plants	13	4

The spatial distribution of the 3 macrophyte types in Balsam Lake are presented in Figure 3. Submersed aquatic plants covered 770 acres or 37 percent of the lake's surface area. Floating aquatic plants covered 301 acres or 15 percent of the lake's surface area. Emergent plants covered 61 acres or 3 percent of the lake's surface area. A comparison of the spatial distribution of submergent, floating, and emergent vegetation during 1999 and 2005 are presented in Figures 4, 5, and 6.

4.1.2 Number of Species

The large number of species noted in Balsam Lake is indicative of a stable and healthy aquatic plant community. Specifically, a total of 21 species were found in 2005 and 25 species were found in 1999. The presence of a large number of species:

- Provides a diverse habitat for fish and invertebrates (i.e., food for fish) and encourages a more diverse fish and invertebrate community;

Protects fisheries' habitat from destruction by a disease as a species-specific disease would only impact one species and have little impact upon the diverse community.

4.1.3 Frequently Occurring Species

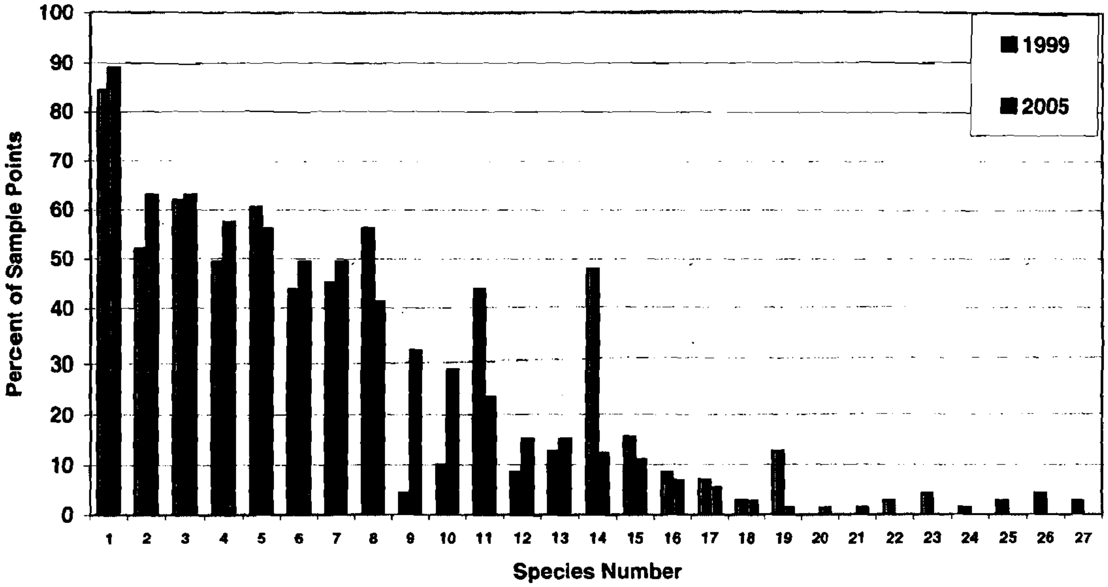
Although a diverse aquatic plant community was observed, a few species were abundant. One measure of abundance is the frequency of occurrence of a species measured as the percentage of sample locations containing a species. As shown in Figure 7, the 5 most frequently occurring species in Balsam Lake during 2005 were:

- *Ceratophyllum demersum* (coontail) was found in 89 percent of the sample locations
- *Potamogeton robbinsi* (Robbin's pondweed) was found in 63 percent of the sample locations
- *Potamogeton zosteriformis* (flatstem pondweed) was found in 63 percent of the sample locations
- *Elodea Canadensis* (Elodea) was found in 58 percent of the sample locations
- *Valisneria americana* (wild celery) was found in 56 percent of the sample locations

A comparison of frequency of occurrence of the lake's plant species during 1999 and 2005 (See Figure 7) indicates little change occurred during this period. During 1999 and 2005, four of the five dominant species were the same and their frequency of occurrence values generally differed by less than 10 percent (range of 1 to 11 percent). A comparison of 1999 and 2005 frequency of occurrence data indicates 74 percent of the lake's species noted differences in values that were less than 10 percent.

Curlyleaf pondweed was one of seven species noting a change in frequency of occurrence between 1999 and 2005 that was greater than 10 percent. The frequency of occurrence of curlyleaf pondweed (*Potamogeton crispus*) was 15 percent lower in 2005 than 1999 (56 percent in 1999 and 41 percent in 2005). Curlyleaf pondweed was the 4th most dominant species in 1999 and was the 8th most dominant species in 2005. The reduced frequency of curlyleaf pondweed in 2005 was a favorable change for Balsam Lake's plant community.

Figure 7. Comparison of 1999 and 2005 Balsam Lake Frequency of Occurrence



Species Number	Scientific Name	Common Name	1999 Frequency (% of Sample Points)	2005 Frequency (% of Sample Points)
1	*Ceratophyllum demersum*	coontail	84	89
2	*Potamogeton robbinsii*	Robbins' pondweed	52	63
3	*Potamogeton zosteriformis*	flatstem pondweed	62	63
4	*Elodea canadensis*	Canada waterweed	49	58
5	*Vallisneria americana*	wild celery	61	56
6	*Myriophyllum sibiricum*	northern watermilfoil	44	49
7	*Potamogeton richardsonii*	Richardson's pondweed	45	49
8	*Potamogeton crispus*	curlyleaf pondweed	56	41
9	*Zosterella dubia*	water stargrass	4	32
10	*Potamogeton amplifolius*	largeleaf pondweed	10	29
11	*Lemna trisulca*	star duckweed	44	23
12	*Nuphar variegata*	spatterdock	9	15
13	*Ranunculus spp.*	water crowfoot	13	15
14	*Potamogeton sp.*	narrow leaf pondweed	48	12
15	*Nymphaea tuberosa*	white waterlily	16	11
16	*Potamogeton illinoensis*	Illinois pondweed	9	7
17	*Chara spp.*	muskgrass	7	5
18	*Eleocharis spp.*	spikerush	3	3
19	*Najas flexilis*	bushy naiad	13	1
20	*Nitella spp.*	stonewort	0	1
21	*Potamogeton natans*	floatingleaf pondweed	0	1
22	Brasenia Schreberi	watershield	3	0
23	Lemna minor	lesser duckweed	4	0
24	Potamogeton pusillus	small pondweed	1	0
25	Sagittaria sp.	arrowhead	3	0
26	Spirodela Polyrhiza	greater duckweed	4	0
27	Wolffia columbiana	water meal	3	0

4.1.4 Density of Individual Species

2005 aquatic plant density in Balsam Lake ranged from 0 to 5 (See Methods Section—0 denotes no macrophytes and densities of 1 through 5 denote increasing plant density to a maximum density denoted by 5). Densities denoted by each individual species in Balsam Lake were averaged to determine average density. All species noted an average density of less than 1.5 in 2005, which is a light density (See Figure 8). The three species noting the highest average density were:

- *Ranunculus spp.* (water crowfoot) noted an average density of 1.14 (a coverage of approximately 23 percent of the rake head);

- *Ceratophyllum demersum* (coontail) noted an average density of 1.06 (a coverage of approximately 21 percent of the rake head);

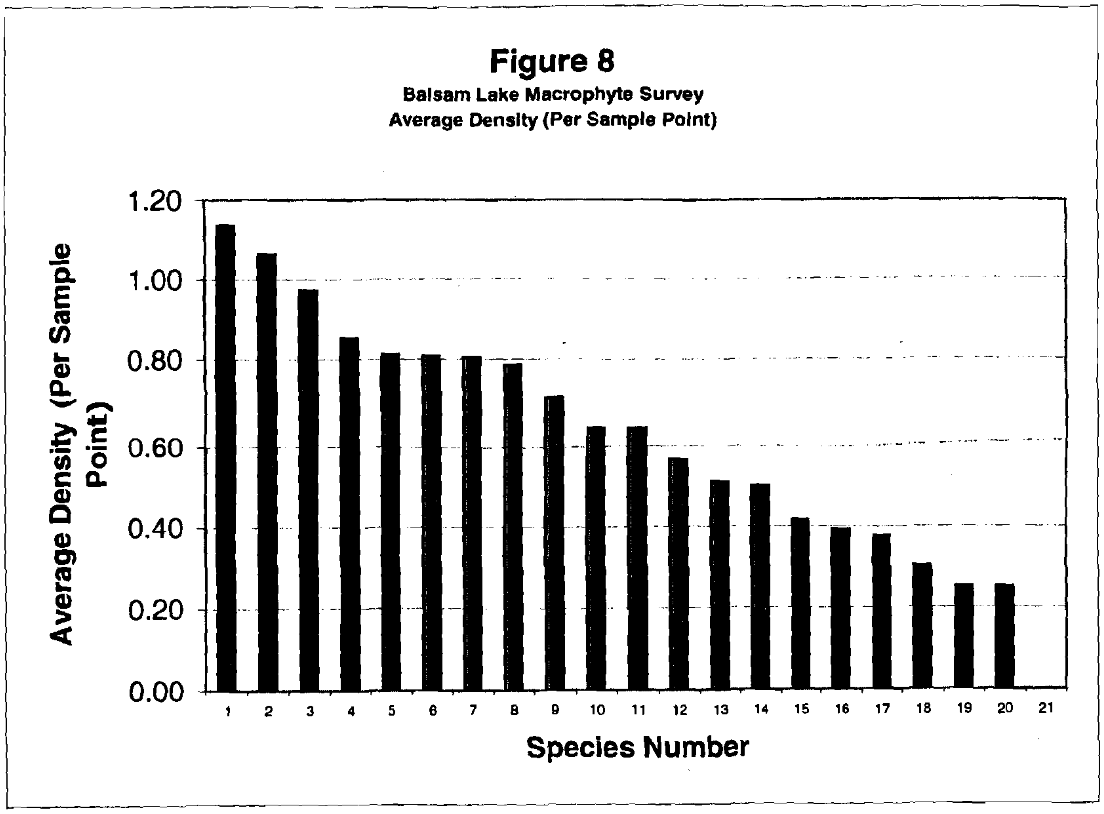
- *Potamogeton robbinsii* (Robbin's pondweed) noted an average density of 0.97 (a coverage of approximately 19 percent of the rake head).

Although on average, the lake's plant species noted a light density, heavy densities of some species were observed in some portions of the lake during 2005. Individual species' densities ranged from 0 to 5 (See Table 2). The 3 species noting the highest densities are the same 3 species noting the highest average densities:

- *Ceratophyllum demersum* (coontail)—maximum density of 5.00 (a coverage of 100 percent of the rake head)

- *Potamogeton robbinsii* (Robbin's pondweed) –maximum density of 4.00 (a coverage of 80 percent of the rake head)

- *Ranunculus spp.* (water crowfoot)—maximum density of 3.25 (a coverage of 65 percent of the rake head).



Species Number	Scientific Name	Common Name	Average Density Per Sample Point
1	Ranunculus spp.	water crowfoot	1.14
2	Ceratophyllum demersum	coontail	1.06
3	Potamogeton robbinsii	Robbins' pondweed	0.97
4	Lemna trisulca	star duckweed	0.85
5	Nymphaea tuberosa	white waterlily	0.81
6	Elodea canadensis	Canada waterweed	0.81
7	Potamogeton sp.	narrow leaf pondweed	0.81
8	Potamogeton amplifolius	largeleaf pondweed	0.79
9	Nuphar variegata	spatterdock	0.70
10	Potamogeton crispus	curlyleaf pondweed	0.63
11	Myriophyllum sibiricum	northern watermilfoil	0.63
12	Vallisneria americana	wild cerlery	0.57
13	Zosterella dubia	water stargrass	0.51
14	Eleocharis spp.	spikerush	0.50
15	Potamogeton richardsonii	Richardson's pondweed	0.42
16	Potamogeton zosteriformis	flatstem pondweed	0.39
17	Chara spp.	muskgrass	0.38
18	Potamogeton illinoensis	Illinois pondweed	0.30
19	Najas flexilis	bushy naiad	0.25
20	Nitella spp.	stonewort	0.25
21	Potamogeton natans	floatingleaf pondweed	0.00

P:\49\49\033\Average Density.xls

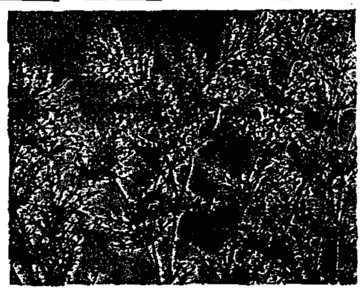
Table 2. 2005 Balsam Lake Aquatic Plants			
Common Name	**Scientific Name**	**2005 Density**	**Picture**
Submerged Aquatics			
Coontail	*Ceratophyllum demersum*	0.25– 5.00	
Muskgrass	*Chara spp.*	0.25 – 0.75	
Canada waterweed	*Elodea canadensis*	0.25 – 3.00	
Northern watermilfoil	*Myriophyllum Sibiricum.*	0.25 –2.75	

Table 2. 2005 Balsam Lake Aquatic Plants (Continued)			
Common Name	**Scientific Name**	**2005 Density**	**Picture**
Submerged Aquatics			
Stonewort	*Nitella sp.*	0.25	
Largeleaf pondweed	*Potamogeton amplifolius*	0.0– 2.00	
Curlyleaf pondweed	*Potamogeton crispus*	0.00-2.75	
Illinois pondweed	*Potamogeton illinoensis*	0.25 – 0.5	

Table 2. 2005 Balsam Lake Aquatic Plants (Continued)

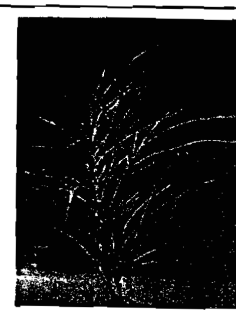
Common Name	Scientific Name	2005 Density	Picture
	Submerged Aquatics		
Richardson's pondweed	*Potamogeton Richardsonii*	0.00-1.25	
Robbin's pondweed	*Potamogeton robbinsii*	0.25 – 4.00	
Flatstem pondweed	*Potamogeton zosteriformis*	0.00– 1.00	

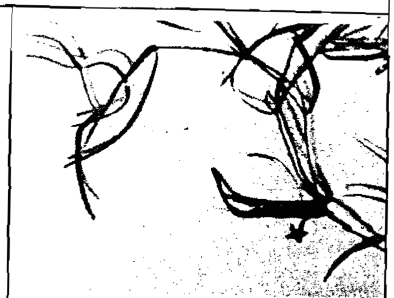
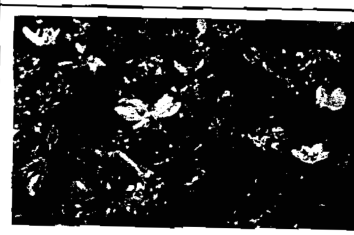
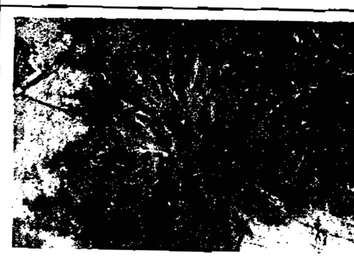
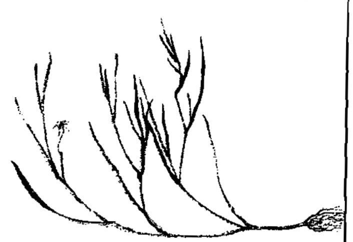
Table 2. 2005 Balsam Lake Aquatic Plants (Continued)			
Common Name	**Scientific Name**	**2005 Density**	**Picture**
Submerged Aquatics			
Narrowleaf pondweed	*Potamogeton sp.* (Shown: *P. foliosus*)	0.25 – 1.25	
Water crowfoot	*Ranunculus spp.*	0.25 – 3.25	
Bushy naiad	*Najas flexilis*	0.25	
Wild celery	*Vallisneria Americana*	0.25 – 1.00	
Water stargrass	*Zosterella dubia.*	0.25 – 2.00	

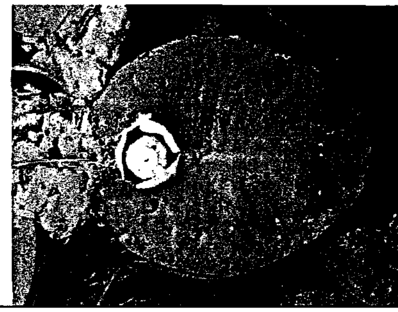
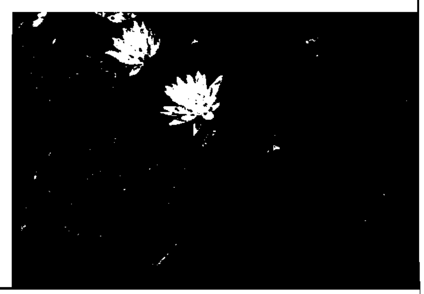
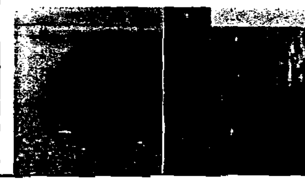
Table 2. 2005 Balsam Lake Aquatic Plants (Continued)			
Common Name	**Scientific Name**	**2005 Density**	**Picture**
Floating Leaf Plants			
Spadderdock	*Nuphar variegata*	0.00 – 2.00	
White waterlily	*Nymphaea tuberose*	0.00-2.50	
Star duckweed	*Lemna trisulca*	0.25-2.75	

Table 2. 2005 Balsam Lake Aquatic Plants (Continued)			
Common Name	**Scientific Name**	**2005 Density**	**Picture**
Emergent Plants			
Spikerush	*Eleocharis sp.*	0.25-0.75	

4.1.5 Total Aquatic Plant Density (Cumulative Total of All Species)

In 2005, total plant density in Balsam Lake was generally moderate. As shown in Figure 9, average rake density generally ranged from 0.5 (10 percent of rake head covered) to 2.75 (55 percent of rake head covered). Despite the moderate growth in most portions of the lake, problematic plant growths were observed in some portions of Balsam Lake. In these areas, average rake densities ranged from 2.75 (55 percent of rake head covered) to 4.75 (95 percent of rake head covered. The lake's 2005 total aquatic plant density was generally similar to the lake's 1999 aquatic plant density (See Figure 10). Differences include reduced plant density in Little Balsam Lake and the north central littoral area of the Main Basin of Balsam Lake during 2005.

4.1.6 Aquatic Plant Diversity

As shown in Figure 11, the lake's 2005 plant community consisted of a diverse assemblage of many species rather than dominance by a few species. To determine the diversity of this assemblage, an aquatic plant diversity calculation was completed for Balsam Lake using a modification of Simpson's Index (1949):

$1-\sum(rf/100)^2$

Where:

rf = the relative frequency of each species.

Frequencies were calculated as the number of sampling points where a species occurred divided by the total number of sampling points at depths less than or equal to the maximum depth of plant growth. Frequencies were relativized to 100 percent to describe community structure (i.e., rf). Frequencies and relative frequencies are presented in Appendix A.

The data indicate a highly diverse plant community was found in Balsam Lake. On a scale of 0 to 1, with 0 indicating no plant diversity and 1 indicating the highest plant diversity, Balsam Lake noted a diversity of 0.93. The diversity measured in Balsam Lake in 2005 is the second highest diversity noted for 56 Wisconsin Lakes (See Table 3). The diversity in 2005 (0.93) was slightly higher than the diversity in 1999 (0.92).

4.1.7 Percent Open Area

The cumulative effect of the lake's diverse aquatic plant community was assessed from the proportion of open area in the littoral zone (i.e., Percent Open Area). The percent open area was estimated from the number of sampling points containing no vegetation divided by the total number of sampling points at a depth less than or equal to the maximum depth of plant growth. Maximum depth of plant growth is the deepest water depth at which plant growth was found. The maximum depth of plant growth in Balsam Lake was 16 feet. All of the sampling points monitored during 2005 contained vegetation. Hence, no open area was noted in Balsam Lake.

4.1.8 Functions and Values of Aquatic Plants

The Balsam Lake aquatic plant community (See Appendix B) performs a number of valuable functions. These include:

- Habitat for fish, insects, and small aquatic invertebrates
- Food for waterfowl, fish, and wildlife
- Oxygen producers
- Provide spawning areas for fish in early spring
- Helps stabilize marshy borders of the lake; helps protect shorelines from wave erosion
- Provides nesting sites for waterfowl and marsh birds

Table 3 Diversities of Some Wisconsin Plant Communities (from Nichols 1997 and Barr 2001-2005)—Samples Collected by WDNR Unless Otherwise Indicated

Lake Name	Diversity	Lake Name	Diversity
Amnicon Lake	0.95	Como Lake	0.88
Balsam Lake 2005	**0.93***	White Ash Lake, North	0.88**
Church Pine Lake	0.93*	Dowling Lake	0.87
Decorah Lake	0.93	Chute Pond	0.86
Half Moon Lake	0.93	Enterprise Lake	0.86
Spider Chain of Lakes—North Lake	0.93*	Okauchee Lake	0.86
Balsam Lake 1999	**0.92***	Pearl Lake	0.86
Beaver Dam Lake (West)	0.92**	Bear Lake	0.85
Muskellunge Lake	0.92	Big Butternut Lake	0.84
Round (Wind) Lake	0.92*	Beaver Dam Lake (East)	0.81**
Spider Chain of Lakes—Fawn Lake	0.92*	Long Lake T32N	0.81
Spider Chain of Lakes--Spider Lake (north)	0.92*	Twin Lake, South	0.81
Apple River Flowage	0.91	Helen Lake	0.80
Ashippun Lake	0.91	McCann Lake	0.80
Big Blake Lake (Blake)	0.91*	Cary Pond	0.79
Cedar Lake	0.91	Island Lake	0.78
Little Elkhart Lake	0.91	Leota Lake	0.78
Pine Lake	0.91	Little Arbor Vitae Lake	0.78
Post Lake	0.91	Mid Lake (Nawaii)	0.78
Morris Lake (Mt. Morris)	0.91	Half Moon Lake T47N	0.77
Sand Lake	0.91*	Clear Lake	0.74
White Ash Lake*	0.91**	Chain Lake	0.74
Pike Lake	0.90	Twin Lake North	0.73
Mud Hen Lake	0.90	Rib Lake	0.71
Spider Chain of Lakes--Spider Lake (south)	0.90*	Oconomowoc Lake, Upper	0.70
Big Round Lake	0.89	Silver Lake (Anderson)	0.69
Pigeon Lake	0.89	Tichigan Lake	0.69
Big Hills Lake (Hills)	0.88	George Lake	0.58
Spider Chain of Lakes—Clear Lake	0.88*		

*Sampled by Barr Engineering Company **Sampled by volunteers trained by Barr Engineering Company

Functions of individual species found in Balsam Lake are presented in Table 4.

Table 4 Functions of Aquatic Plant Species Found in Balsam Lake*

Scientific Name (Common Name)	Plant Type	Plant Functions
Ceratophyllum demersum (Coontail)	Submersed	Many waterfowl species eat the shoots; it provides cover for young bluegills, perch, largemouth bass, and northern pike; supports insects that fish and ducklings eat.
Chara spp. (Muskgrass)	Submersed	Muskgrass is a favorite waterfowl food. Algae and invertebrates found on muskgrass provide additional grazing. It is also considered valuable fish habitat. Beds of muskgrass offer cover and are excellent producers of food, especially for largemouth bass and smallmouth bass.
Eleocharis spp (Spike Rush)	Emergent	Spike rush provides food for a variety of waterfowl as well as muskrats. Submersed beds offer habitat and shelter for invertebrates and small fish.
Elodea canadensis (Canada Waterweed)	Submersed	Provides habitat for many small aquatic animals, which fish and wildlife eat.
Lemna trusulca (star duckweed)	Floating	Star duckweed is a good food source for waterfowl. Tangled masses of fronds also provide cover for fish and invertebrates.
Myriophyllum sibericum (formerly exalbescens) (Northern Milfoil)	Submersed	Provides cover for fish and invertebrates; supports insects and other small animals eaten by fish; waterfowl occasionally eat the fruit and foliage.
Najas flexilis (bushy naiad)	Submersed	Bushy naiad is one of the most important plants for waterfowl. Stems, leaves, and seeds are all consumed by a wide variety of ducks including black duck, bufflehead, canvasback, gadwall, mallard, pintail, redhead, ringnecked duck, scaup, shoveler, blue-winged teal, green-winged teal, wigeon, and wood duck. It is also important to a variety of marsh birds as well as muskrats.
Nitella sp. (Stonewort)	Submersed	*Nitella* is sometimes grazed by waterfowl. The algae and invertebrates on the surface are attractive to ducks and geese. *Nitella* also offers foraging opportunities for fish.
Nuphar variegata (Spadderdock)	Floating	Spadderdock anchors the shallow water community and provides food for many residents. It provides seeds for waterfowl including mallard, pintail, ringneck and scaup. The leaves, stems and flowers are grazed by deer. Muskrat, beaver and even porcupine have been reported to eat the rhizomes. The leaves offer shade and shelter for fish as well as habitat for invertebrates.
Nymphaea tuberosaa (White Water Lily)	Floating	White water lily provides seeds for waterfowl. Rhizomes are eaten by deer, muskrat, beaver, moose and porcupine. The leaves offer shade and shelter for fish.
Potamogeton amplifolius (Large-leaf Pondweed)	Submersed	The broad leaves of *Potamogeton amplifolius* offer shade, shelter and foraging opportunities for fish. Abundant production of large nutlets makes this a valuable waterfowl food.
Potamogeton crispus (Curlyleaf pondweed)	Submersed	Provides some cover for fish; several waterfowl species feed on the seeds; diving ducks often eat the winter buds.
Potamogeton Illinoensis (Illinois Pondweed)	Submersed	The fruit produced by Illinois pondweed can be a locally important food source for a variety of ducks and geese. The plant may also be grazed by muskrat, deer, beaver, and moose. This pondweed offers excellent shade and cover for fish and good surface area for invertebrates.

Scientific Name (Common Name)	Plant Type	Plant Functions
Potamogeton natans (Floating-leaf Pondweed)	Submersed	The fruit of floating-leaf pondweed is held on the stalk until late in the growing season. This provides valuable grazing opportunities for ducks and geese including scaup and blue-winged teal. Portions of this pondweed may also be consumed by muskrat, beaver, deer, and moose. Floating-leaf pondweed is considered good fish habitat because it provides shade and foraging opportunities.
Potamogeton Richardsonii (Clasping-leaf Pondweed)	Submersed	The fruit produced by clasping-leaf pondweed can be a locally important food source for a variety of ducks and geese including black duck, canvasback, redhead, ring-necked duck, and green-winged teal. The plant may also be grazed by muskrat, deer, beaver, and moose. The leaves and stem are colonized by invertebrates and offer foraging opportunities and cover for fish.
Potamogeton robbinsii (Robbin's Pondweed)	Submersed	Robbin's pondweed provides habitat for invertebrates that are grazed by waterfowl. It also offers good cover and foraging opportunities for fish, particularly northern pike.
Potamogeton zosteriformis (Flat-stem Pondweed),	Submersed	Flat-stem pondweed can be a locally important food source for a variety of geese and ducks including redhead and green-winged teal. The plant may also be grazed by muskrat, deer, beaver, and moose. Flat-stem pondweed provides a food source and cover for fish and invertebrates.
Ranunculus spp. (Water Crowfoot)	Submersed	As flowers give way to fruit, the water crowfoot bed becomes a choice spot for dabbling ducks. Both fruit and foliage of water crowfoot are consumed by a variety of waterfowl. When it is growing in shallow zones, it is sometimes consumed by upland game birds including ruffed grouse. Stems and leaves of water crowfoot provide valuable invertebrate habitat.
Vallisneria americana (Wild Celery)	Submersed	Wild celery is a premiere source of food for waterfowl. All portions of the plant are consumed including foliage, rhizomes, tubers, and fruit. Wild celery beds become a prime destination for thousands of canvasback ducks every fall. Wild celery is also important to marsh birds and shore birds including rail, plover, sand piper, and snipe. Muskrats are also known to graze on it. Beds of wild celery are considered good fish habitat providing shade, shelter, and feeding opportunities.
Zosterella dubia (Water Star Grass)	Submersed	Water star grass can be a locally important source of food for geese and ducks including northern pintail, blue-winged teal and wood duck. It also offers good cover and foraging opportunities for fish.

*Plant functions are from: Borman, S. et al. 1997. Through the Looking Glass...A Field Guide to Aquatic Plants and Minnesota Department of Natural Resources. 1997. A Guide to Aquatic Plants--Identification and Management.

4.1.9 Wisconsin Floristic Quality Assessment

The Balsam Lake plant community was assessed using the Wisconsin Floristic Quality Assessment (WFQA). The WFQA is an adaptation for use in Wisconsin of the original floristic quality assessment method developed for the Chicago region (Swink and Wilhelm 1994). The basis of the floristic quality assessment is the concept of species conservatism, the degree to which a species can tolerate disturbance and its fidelity to undegraded conditions. Conservatism is not always equated with rarity. The method uses the aggregate conservatism of all species found on a site as a measure of the site's intactness, an indication of its ecological integrity (Bernthal 2003).

The method requires the *a priori* assignment of "coefficients of conservatism" to every aquatic plant species in a regional flora, relying on the collective knowledge of a group of experts. The coefficients for Wisconsin aquatic plants were assigned by a group of aquatic ecologists led by Stanley Nichols (Bernthal 2003)

The method requires an accurate and complete inventory of aquatic plants within a lake. The appropriate coefficient is applied to each species, and an average coefficient of conservatism (Mean C) is calculated for the entire lake. The Floristic Quality Index (FQI) adds a weighted measure of species richness by multiplying the Mean C by the square root of the total number of native species. FQI = Mean C * $\sqrt{N}$

Where:

Mean C = $\sum(c_1+c_2+c_3+\ldots c_n)/N$

Non-native species are assigned a C value of 0. Higher Mean C and FQI numbers indicate higher floristic integrity and a lower level of disturbance impacts to the site (Bernthal 2003)

The method is based on the concept of species conservatism. Each native aquatic plant species occurring in a regional flora is assigned a coefficient of conservatism (C) representing an estimated probability that a species is likely to occur in a lake relatively unaltered from what is believed to be a pre-settlement condition. The most conservative species require a narrow range of ecological conditions, are intolerant of disturbance, and are unlikely to be found outside undegraded remnant natural settings, while the least conservative species can be found in a wide variety of settings, and thrive on disturbance. Coefficients range from 0 (highly tolerant of disturbance, little fidelity to any natural community) to 10 (highly intolerant of disturbance, restricted to pre-settlement remnants). Conceptually this 10-point scale can be subdivided into several ranges.

- 0-3—taxa found in a wide variety of plant communities and very tolerant of disturbance

- 4-6—taxa typically associated with a specific plant community, but tolerate moderate disturbance

- 7-8—taxa found in a narrow range of plant communities, but can tolerate minor disturbance

- 9-10—taxa restricted to a narrow range of synecological conditions, with low tolerance of disturbance (Bernthal 2003)

In 2005, the Mean C of Balsam Lake was 6 and the FQI was 27.4 (See Figure 12). The Mean C of 6 indicates the lake's plant community is tolerant of moderate disturbance. The median FQI for Wisconsin is 22.2 (WDNR 2005). Balsam Lake's FQI is higher than the median Wisconsin Lake, indicating the lake's plant community is of higher quality and less tolerant to disturbance than the plant community of the median Wisconsin lake.

4.2 Comparison of 1999 and 2005 Data

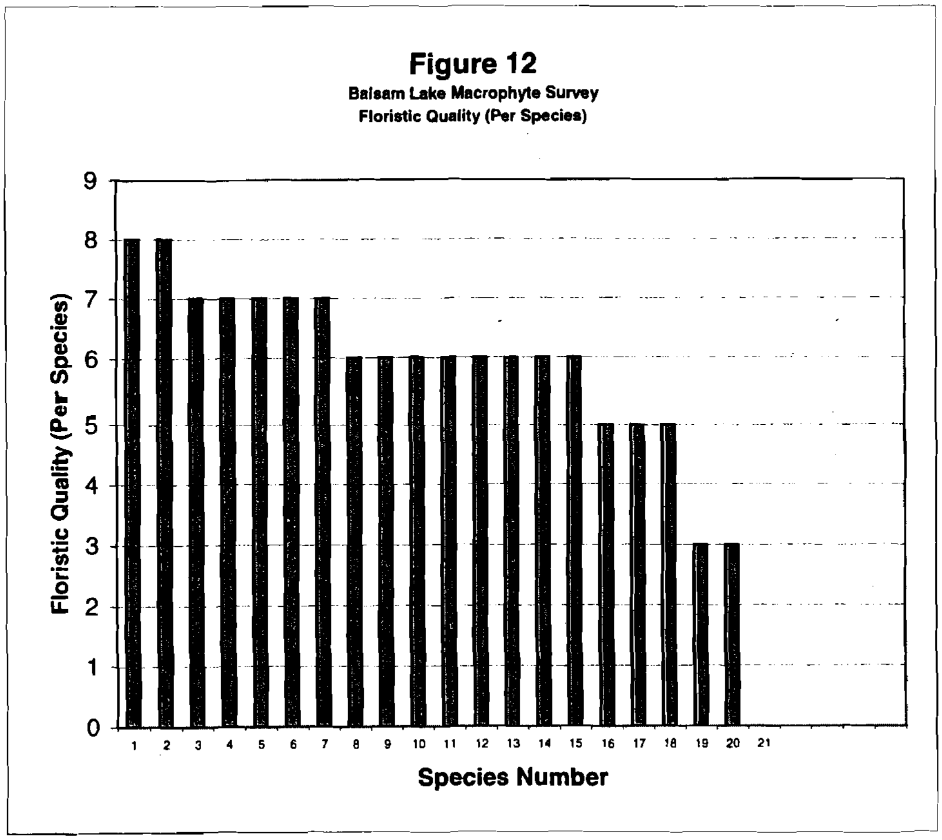
A comparison of aquatic plant survey data from 1999 and 2005 indicates Balsam Lake's aquatic plant community has changed little over time. The percent similarity (C) is a means of comparing data from the two surveys by estimating the degree to which the communities share common components. Percent similarity C is computed as follows:

$$C_{ij} = 1 - 1/2\sum_{k=1}^{s} |p_{ik}-p_{ij}|)$$

Where C_{ij} = percent similarity between survey the first sampling in 1999 and the second sampling in 2005.

$\sum_{k=1}^{s}$ = summing over all species, from species k=1 to the last species (k=s)

$|p_{ik}-p_{jk}|$ = absolute value of the relative frequency of species k at sampling period I (or the first sampling in 1999) minus the relative frequency of species k at sampling period j (or the second sampling in 2005).



Species Number	Scientific Name	Common Name	Floristic Quality
1	*Potamogeton sp.*	narrow leaf pondweed	8
2	*Potamogeton robbinsii*	Robbins' pondweed	8
3	*Chara spp.*	muskgrass	7
4	*Myriophyllum sibiricum*	northern watermilfoil	7
5	*Nitella spp.*	stonewort	7
6	*Potamogeton amplifolius*	largeleaf pondweed	7
7	*Ranunculus spp.*	water crowfoot	7
8	*Lemna trisulca*	star duckweed	6
9	*Najas flexilis*	bushy naiad	6
10	*Nuphar variegata*	spatterdock	6
11	*Nymphaea tuberosa*	white waterlily	6
12	*Potamogeton illinoensis*	Illinois pondweed	6
13	*Potamogeton zosteriformis*	flatstem pondweed	6
14	*Vallisneria americana*	wild cerlery	6
15	*Zosterella dubia*	water stargrass	6
16	*Eleocharis spp.*	spikerush	5
17	*Potamogeton natans*	floatingleaf pondweed	5
18	*Potamogeton richardsonii*	Richardson's pondweed	5
19	*Ceratophyllum demersum*	coontail	3
20	*Elodea canadensis*	Canada waterweed	3
21	*Potamogeton crispus*	curlyleaf pondweed	0

The maximum similarity, in which there is the same frequency of each species at both sampling times, is 1. The minimum similarity, where there is no overlap of any species, is 0. Balsam Lake noted a similarity of 0.9, which is very close to the maximum similarity of 1. The data indicate the lake's plant community is very stable and has changed little during the 1999 through 2005 period (See Figure 13).

4.3 Aquatic Invasive Species

In 2005, aquatic plants in Balsam Lake consisted almost exclusively of native species (i.e., species historically present in this region). One non-native or aquatic invasive species (AIS) occurred in the lake, *Potamogeton crispus* (curlyleaf pondweed, CLP). AIS are undesirable because their natural control mechanisms are not introduced with the species. Consequently, AIS frequently exhibit unchecked growth patterns. However, native plants sometimes successfully compete with AIS, limiting their coverage and preventing increased coverage.

Balsam Lake's native vegetation has successfully competed against curlyleaf pondweed during 1999 through 2005. Percent similarity C was computed for curlyleaf pondweed to determine the similarity of the curlyleaf pondweed community during 1999 and 2005. The relative frequency of curlyleaf pondweed declined by 0.15 (15 percent) during the 1999 through 2005 period. The percent similarity computed for the 1999 and 2005 curlyleaf pondweed community is 0.93 which is very close to the maximum similarity of 1. The data indicate the lake's curlyleaf pondweed community is stable and has changed little during the 1999 through 2005 period.

A comparison of 1999 and 2005 curlyleaf pondweed coverage and density indicates that an overall decline in curlyleaf pondweed coverage occurred during this period (See Figure 14). Specifically, a total of 23 sample stations (32 percent) noted decreased coverage or density of curlyleaf pondweed during 2005 and 10 sample stations (14 percent) noted increased coverage or density of curlyleaf pondweed during 2005. The number of stations noting reduced coverage and density of curlyleaf pondweed in 2005 exceeded the number of stations noting increased coverage and density. CLP coverage declined from 583 acres in 1999 to 443 acres in 2005, a coverage reduction of 24 percent. The data indicate an overall decrease in curlyleaf pondweed coverage and abundance.

4.4 Balsam Lake Water Quality Data

Balsam Lake Secchi disc water transparency data were collected from Little Balsam Lake during 1987 through 2003, from the Main Basin of Balsam Lake during 1987 through 2001, and from East Balsam Lake during 1987 through 2002. Secchi disc water transparency is a measure of water clarity, and is inversely related to algal abundance. Water clarity determines recreational use impairment and also determines light availability to aquatic plants.

An evaluation of Balsam Lake Secchi disc water transparency data was completed based upon a standardized lake rating system. The rating system uses Secchi disc water transparency data to determine a lake's trophic status, which indicates how good or poor the lake's water transparency is. The four categories in the rating system are oligotrophic, excellent water transparency, mesotrophic, good water transparency, eutrophic, poor water transparency, and hypereutrophic, very poor water transparency. Figures 15 through 17 summarize the average summer Secchi disc transparencies for Little Balsam, the Main Basin of Balsam, and East Balsam Lake during the 1987 through 2003 period. Also shown on each graph are the four trophic categories.

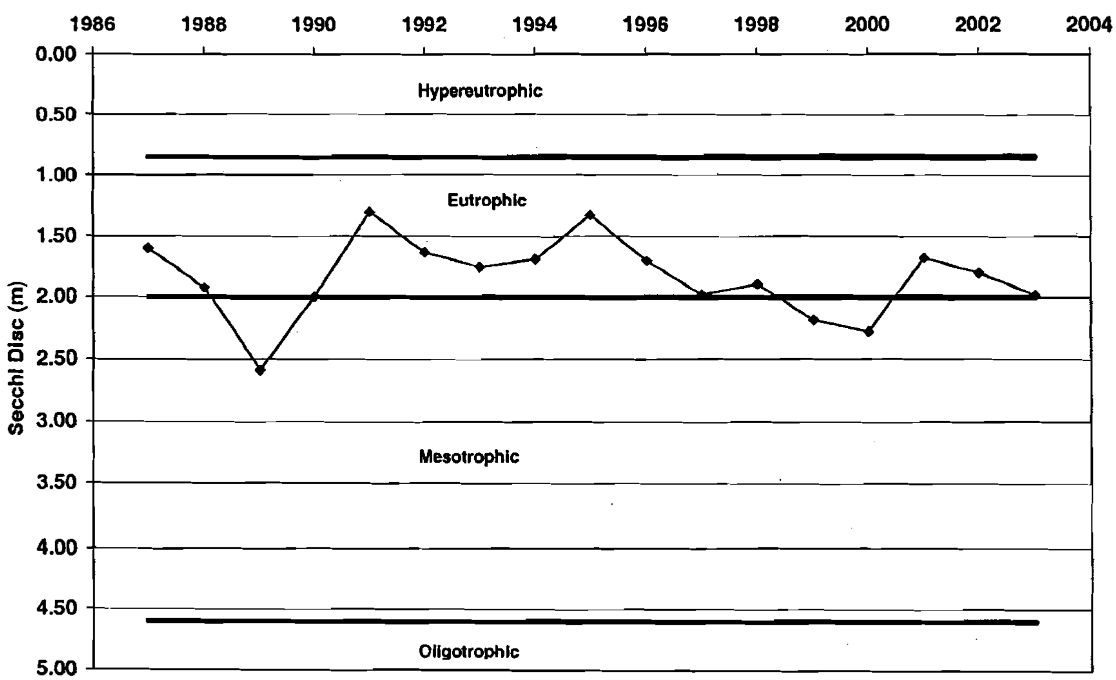


Figure 15. 1987-2003 Little Balsam Lake Secchi Disc Water Transparency

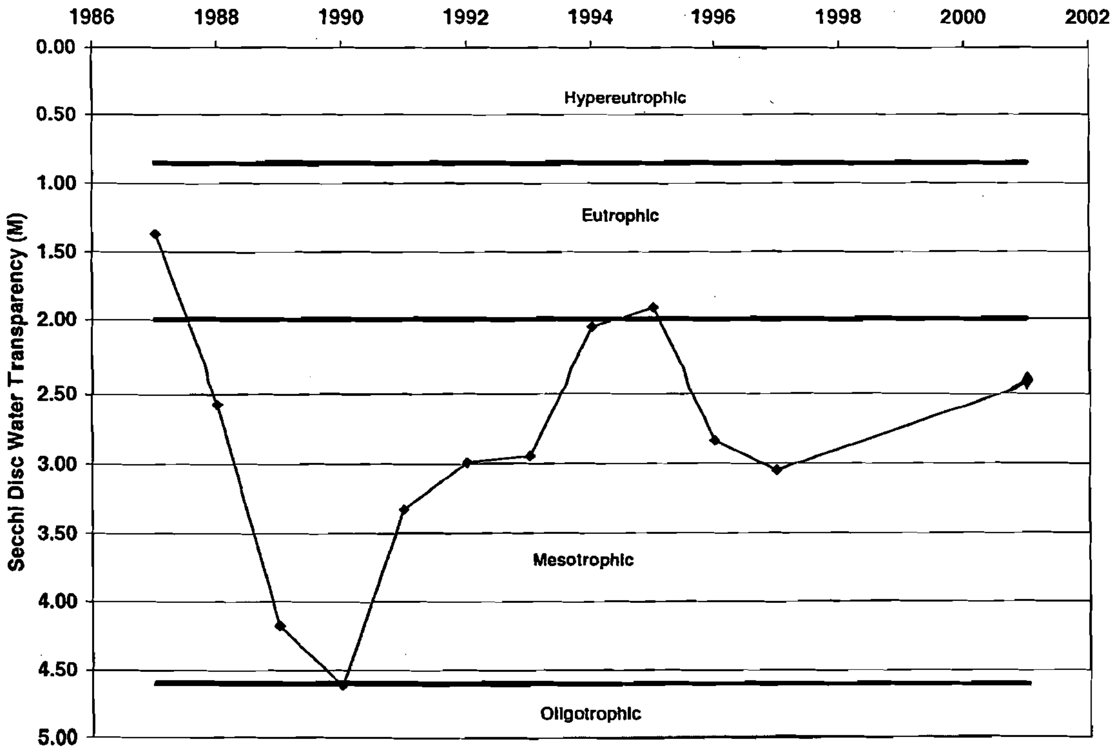


Figure 16. 1987-2001 Balsam Lake Main Basin Secchi Disc Water Transparency

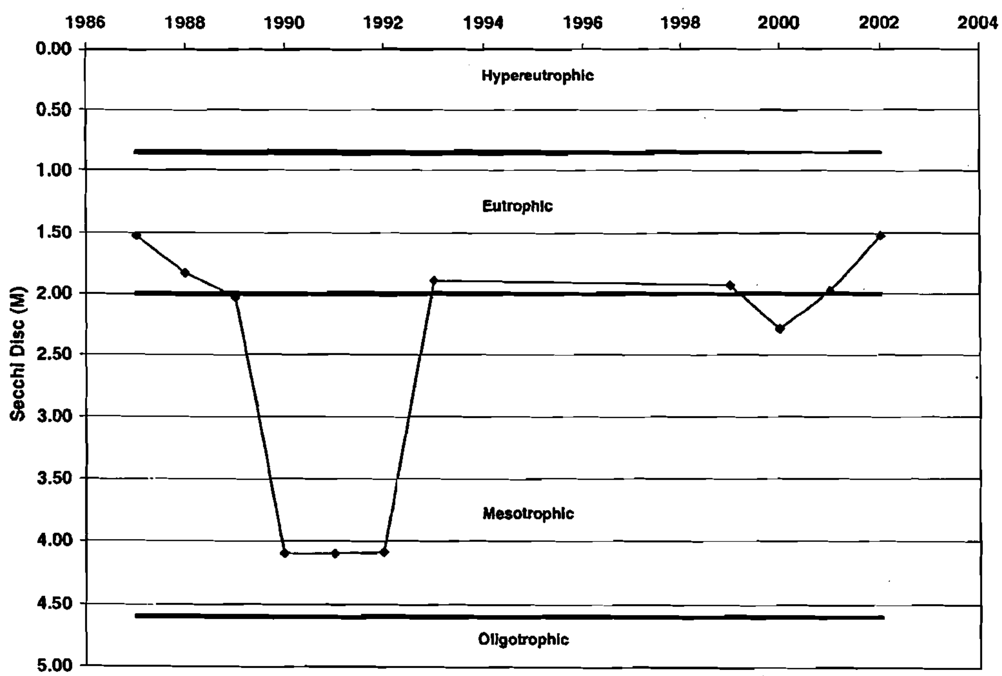


Figure 17. 1987-2002 East Balsam Lake Secchi Disc Water Transparency

Balsam Lake Secchi disc evaluation results follow.

- Secchi disc transparency data from Little Balsam Lake were generally in the eutrophic (poor) category. During 1989, 1999, and 2000, average summer values were within the mesotrophic (good) category and values were in the eutrophic category during all other years (81 percent of values).

- Secchi disc transparency data from the Main Basin of Balsam Lake were generally within the mesotrophic (good) category (75 percent of values). During 1987 and 1995, average summer values were within the eutrophic (poor) category. During 1995, the average summer value was borderline oligotrophic (excellent) and mesotrophic (good).

- Approximately half of the average summer Secchi disc values from East Balsam Lake were within the mesotrophic (good) category and half were within the eutrophic (poor) category. Many of the values within the eutrophic category were near the mesotrophic and eutrophic borderline, indicating the lake's water quality was mildly eutrophic.

- The long-term average summer water transparency values of the Main Basin and East Basin of Balsam Lake are 2.86 and 2.48 meters, respectively. Both values are in the mesotrophic category (good water transparency).

- The long-term summer average water transparency of Little Balsam Lake is 1.84 meters, which is in the eutrophic category (poor water transparency).

4.5 Aquatic Plant Management During 2002 Through 2005

The 2000 Balsam Lake APM Plan recommended an annual herbicide treatment of boat landings, swimming beaches, and navigation channels within the lake. The plan also recommended an early spring herbicide treatment of curlyleaf pondweed in selected areas to reduce CLP growth and restore native aquatic species. The following discussion summarizes herbicide treatments occurring during 2002 through 2005. The discussion is based upon 2002 through 2005 reports published by Aquatic Engineering, Inc.

4.5.1 2002

During 2002, the lake's 5 boat launches were treated during June 26 through July 1 (total of 0.55 acres). On June 26, 10.42 acres of navigation channels were treated. A second treatment of 0.61 acres of navigation channels occurred on July 31 through August 1. The herbicide Reward at a dose of 2 gallons per acre was used for all treatments.

4.5.2 2003

During 2003, the lake's 5 boat launches were treated on June 18 and July 9 (a total of 0.55 acres). On July 9 through 16, 13.6 acres of navigation channels were treated. The herbicide Reward at a dose of 2 gallons per acre was used for all treatments.

4.5.3 2004

During June 14 and July 7-8, the lake's 5 boat launches were treated. On August 12, 13.46 acres of navigation channels were treated. The herbicide Reward at a dose of 2 gallons per acre was used for all treatments.

On June 3, 13 acres were treated with endothall (i.e., Aquathol K liquid) at a concentration of 1.5 ppm. The purpose of the treatment was to reduce CLP growth in the treated areas to the greatest extent possible.

4.5.4 2005

During June 14 and August 10, four boat launches were treated. One boat launch, a private boat launch for a resort, was not treated at the request of the resort owner. On August 8, 4.7 acres of navigation channels were treated. The herbicide Reward at a dose of 2 gallons per acre was used for all treatments.

On June 2 through 3, 13 acres were treated with endothall (i.e., Aquathol K liquid) at a concentration of 1.5 ppm. The purpose of the treatment was to reduce CLP growth in the treated areas to the greatest extent possible.

5.0 Balsam Lake Aquatic Plant Management Plan

An aquatic plant management plan is an orderly and effective approach to plant management. The plan defines the problem, establishes goals, evaluates possible management options, selects a feasible management option, and determines an effective monitoring program to evaluate results of the management strategy. A successful aquatic plant management plan is based upon six principles:

- Define the problem
- Establish goals
- Understand plant ecology
- Consider all the techniques
- Develop management plan
- Monitor the results

5.1 Define the Problem

Balsam Lake has a healthy aquatic plant community that is of higher quality and is less tolerant to disturbance than the plant community of the median Wisconsin lake. The presence of curlyleaf pondweed is of concern because it is not native to this region and has caused problems in lakes throughout the United States by out competing native plants and developing objectionable dense growths. The curlyleaf pondweed community in Balsam Lake is relatively stable and has changed little during the past 6 years. Fluctuations in the community include increasing coverage and densities at some locations and declines at others. Overall, the frequency of occurrence of curlyleaf pondweed has declined by 15 percent over the past 6 years and coverage has declined by 24 percent over the past 6 years.

Despite the favorable attributes of the lake's plant community, dense plant growths at swimming beaches, boat landings, and approximately one third of the lake's navigation channels interfere with the recreational use of the lake. Annual aquatic plant management of swimming beaches, boat landings, and approximately one third of the lake's navigation channels is needed to fully support swimming and boating in Balsam Lake.

Problematic plant density at four locations within Balsam Lake prevent the support of recreational activities and result in a less than ideal fisheries habitat in these areas (See Figure 18). Within these areas, a long-term improvement program is needed to reduce plant density to a moderate level.

5.2 Establish Goals and Objectives

The Balsam Lake Management District has established 7 general and 6 specific aquatic plant management goals for Balsam Lake: The specific goals are divided into 2 categories, goals for an annual maintenance program and goals for a long-term improvement program. The annual maintenance program involves an annual treatment of boat landings, swimming beaches, and navigation channels. The long-term improvement program is intended to attain a long-term change in areas receiving treatment.

5.2.1 General Goals

1) Preserve native species, preserve and/or improve fish and wildlife habitat, protect the lake's ecosystem , and protect and/or improve the quality of Balsam Lake for all to enjoy (i.e., people, fish, wildlife)
2) Remove vegetation from public beach areas and public swimming areas to insure safe swimming conditions
3) Remove vegetation from public boat landings to insure public access to the lake
4) Improve navigation within the lake through areas containing dense plant beds
5) Reduce curlyleaf pondweed density and coverage as warranted to preserve native species, preserve fish and wildlife habitat, protect the lake's ecosystem, and protect the quality of the lake for all to enjoy.
6) Prevent the introduction of additional non-native species to the greatest extent practicable, including education, postings, etc.

7) Protect and, when feasible, improve the water quality of Balsam Lake to protect plant habitat conditions, particularly light conditions to insure the lake's plants have adequate light for growth.

5.2.2 Specific Goals for Annual Maintenance Program

1) Inspect all boat landings and swimming beaches each June and August and treat all areas in need of treatment with Reward.
2) Inspect navigation channels each June and August and treat all areas in need of treatment with Reward.

5.2.3 Specific Goals for Long-Term Improvement Program

1) Select test sites within areas 1 and 2 of Figure 18 and treat with lime slurry to reduce curlyleaf pondweed and limit native plant density to a moderate level (i.e., rake density of less than 2.5).
2) Following attainment of goal 1, treat areas 1, 2, 3, and 4 of Figure 18 and any other areas of the lake with a plant density of at least 3.5 with lime slurry to reduce curlyleaf pondweed and limit native plant density to a moderate level (i.e., rake density of less than 2.5).
3) Following attainment of goal 2, treat selected navigation channels with lime slurry instead of Reward to determine whether lime slurry is more effective or less costly than Reward.
4) Following attainment of goal 3, treat swimming beaches, boat landings, and navigation channels with lime slurry to increase treatment effectiveness and reduce treatment frequency and cost.

5.3 Understand Plant Ecology

Aquatic plant management is based upon an understanding of plant ecology. Understanding the biology of aquatic plants and their habitat requirements is necessary to effectively manage plants. Effective management is necessary to maintain the delicate balance of preservation of fish and wildlife habitat and concurrently provide reasonable lake-use opportunities to area residents.

The biology of aquatic plants and their habitat requirements are inseparably interrelated. The habitat requirements of plants are divided into two general groups, the living group (biotic) and the nonliving group (abiotic). The following discussion of plant habitat requirements is based upon Nichols (1988).

The biotic group contains the predators, parasites, and other organisms which depend upon or compete with an organism for their livelihood. These interrelationships form the basis for biological plant management methods.

The abiotic factors form the basis of plant control techniques involving habitat manipulation, and include those physical and chemical attributes which are necessary for plant growth and development: light, bottom type, water, temperature, wind, dissolved gases and nutrients. Light, water, temperature, dissolved gases and nutrients relate to the plant's ability to carry out the vital processes of photosynthesis and respiration. Bottom type and wind relate to specific physical locations where a plant can grow. The following discussion will show the relationship between critical habitat requirements and possibilities for management.

Both the quantity and quality of light influence plant growth. Light in the red and blue spectral bands is used for photosynthesis; low and high light intensities inhibit photosynthesis. Management activities that make use of shade and dyes, for example, are based on limiting light intensity or changing the spectral qualities of the light. Deepening the lake through dredging or damming is another method of altering the light available to a plant, as light is naturally attenuated in water and the spectral qualities changed.

In the aquatic environment, water is available in abundance and is, therefore, often overlooked as being critical for aquatic plants. Yet, aquatic plants are adapted to growing in an environment with an abundant water supply and are, therefore, sensitive to water stress. Aquatic plants might be controlled by removing their water supply, resulting in the desiccation of the plant.

Plants are generally tolerant of a wide range of temperatures, and temperature fluctuations in the aquatic environment are smaller than in the surrounding aerial environment. Therefore, plant management schemes involving temperature effects depend on artificially exposing aquatic plants to the harsher aerial environment, where not only temperature but desiccation and other factors aid in controlling plant growth.

The two gases of primary importance in the aquatic system are carbon dioxide and oxygen, which are used for photosynthesis and respiration, respectively. The availability of carbon in the form of free CO_2 or bicarbonate appears to influence the distribution of some plant species (Hutchinson, 1970). Although oxygen is many times limiting in the aquatic system, most plants are adapted to living in low oxygen conditions. Because the carbon dioxide reaction is so well buffered by an equilibrium with CO_2 in the air and because the plants are tolerant to low oxygen supplies, the success of any scheme to manage plants by altering the dissolved gases in water seems doubtful.

Aquatic plant problems are caused by nutrient enrichment of the sediment. Nitrogen and phosphorus are the two nutrients of prime concern (Vollenweider, 1968; Sawyer, 1947; Stewart and Rohlich, 1967). Gerloff and Krombholz (1966) and Gerloff (1969) point out that the concentration of nutrients in the habitat may not be related to the concentration in the plant, depending on the availability of the nutrients. Plants remove nutrients in excess of their needs and store excess nutrients (i.e., luxury consumption, Gerloff 1969). These excess nutrient supplies could be used at times when the plant undergoes nutrient stress. These factors inherent in the biology of the plant will have to be overcome when developing practical, in-lake methods of nutrient limitation for aquatic plant control.

Wind and bottom type are physical conditions that may limit plant growth. Heavy winds create waves that tear and uproot the plant, and soil types that are too coarse or are not consolidated enough make rooting very difficult. Some bottom types are rich in nutrients essential for plant growth. Substrates may be altered by removing, covering, or nutrient inactivation.

By manipulating the plant's environment, management tries to induce these limiting conditions and thus restrict the growth of the plants.

5.4 *Identify Beneficial Use Areas*

Beneficial uses of a water body must be compatible with its capacity to sustain those uses, both human and natural. A single water body often supports many different beneficial uses. Aquatic plant growth may impair the beneficial uses of a lake and, hence, may create many use conflicts. The management challenge involves identifying the lake's beneficial uses, and realistically managing for those uses.

Balsam Lake is used for a variety of recreational activities. 1999 membership survey respondents indicate the lake is used for viewing, swimming, fishing, powerboating, waterskiing, canoeing, and other recreational activities. Although 1999 membership survey respondents, indicate aquatic plants cause impairment of all beneficial uses (i.e., swimming, fishing, powerboating, viewing, waterskiing, canoeing, and other recreational uses) (Barr 2000), 2005 aquatic plant survey results indicate the area of the lake requiring plant management is very small (i.e., about 2 percent of the lake's surface area). The vast majority (about 94 percent) of the lake's littoral area has an ideal plant community. Although the area of the lake requiring plant management is small, management of this area is essential to sustain the lake's beneficial uses.

As a first step towards identifying a management plan to sustain the lake's beneficial uses, Balsam Lake Protection and Rehabilitation District Board Members have identified beneficial use areas within the lake that require management to resolve conflicts created by aquatic plant growth. Figure 19 presents these beneficial use areas. The map identifies public and private swimming beaches, swimming rafts, swimming areas, boat landings, and boating passageways. In addition, the results of the 2005 aquatic plant survey identified 4 areas (i.e., areas 1, 2, 3 and 4 on Figure 18) with a plant density of 3.5 or greater (at least 70 percent of the rake head covered). These areas have problematic plant growth that requires management.

In addition to human uses, the lake provides habitat for fish, waterfowl, and other animals. The Wisconsin Department of Natural Resources (WDNR) has identified fish and wildlife sensitive areas in Balsam Lake (See Figure 20). Sensitive areas include habitats that are integral to the lake ecosystem such as nesting sites or fish spawning areas. To protect sensitive areas, plant management within sensitive areas is restricted by the WDNR. In particular, herbicide use within fish sensitive areas is restricted to navigation channels that are necessary to provide boat passageways.

Areas within Balsam Lake with a plant density of 3.5 or greater (Areas 1, 2, 3, and 4 on Figure 18) all coincide with fish and wildlife areas (Figure 20). Management within these areas must protect fish uses as well as support human uses of the lake.

5.5 Consider All Techniques

Following a consideration of all possible management alternatives, a feasible management option may be identified for Balsam Lake. The following discussion focuses on four types of aquatic plant management techniques currently used for aquatic plant control. They include:

1. Physical
2. Mechanical
3. Chemical
4. Biological

5.5.1 Physical

Physical tactics typically used to manage aquatic plants are light manipulation and habitat manipulation. Habitat manipulation includes such techniques as overwinter lake drawdown, dredging, sand blanketing, the use of dyes, and nutrient limitation and inactivation (Barr, 1997).

Although light manipulation has been used in lakes with some success, its greatest utility has been found in managing dense vegetation in streams through streamside shading. Shading by use of different densities of shading cloth has resulted in decreased plant biomass. Natural shade from streamside vegetation has also reduced plant biomass along the stream course (Barr, 1997). Dark colored dyes are sometimes used in small ponds and lakes to reduce aquatic plant growth. The dyes are added to the lake or pond. The resultant change in water color reduces the amount of light reaching the submersed plants, thereby limiting plant growth. Use of dyes is limited to shallow waterbodies with no outflow. Because Balsam Lake is a large lake with an outflow, dyes cannot be used in the lake for plant management.

Lake level drawdown, particularly over winter, is commonly used to control nuisance aquatic plants in northern North America. Biomass studies before and after drawdown have demonstrated that drawdown was effective in controlling plants down to the depth of drawdown, but had no effect at greater depths. While drawdown is an extremely effective technique for some species, it may actually stimulate the growth of other species. (Madsen and Bloomfield, 1992). A study of Trego Flowage (Washburn County, Wisconsin) indicated the benefits of drawdown were temporary, and the same species of plants returned in about their former abundance within a few years (Barr, 1994). Drawdown as a plant management technique is only feasible when a dam is present and lowering the water level for a period of time is feasible. Drawdown is not a feasible option for Balsam Lake.

Another commonly-used group of physical control techniques uses benthic barriers, weed rollers, or sediment alteration to inhibit the growth of aquatic plants at the sediment surface. Barrier material is applied over the lake bottom to prevent plants from growing, leaving the water clear of rooted plants. Benthic barriers are generally applied to small areas (Barr, 1997). Negatively buoyant (i.e., sink in water) screens are available in rolls 7 feet wide and 100 feet long. The screens can be laid on the lake bottom in the spring and removed in the fall. These screens can be reused for about 10 years. Burlap has been found to provide up to 2 to 3 years of relief from problematic growth before eventually decomposing (Truelson 1985 and Truelson 1989). Bottom barriers would be appropriate for controlling aquatic plant nuisances for small applications such as adjacent to a boat dock or from small swimming areas. The barriers are safe, effective, non-chemical control using a simple technology. Bottom barriers do not result in significant production of plant fragments (critical for milfoil treatment). Bottom barriers may cause harm to fisheries and invertebrate habitat. Consequently, the WDNR should be contacted prior to barrier installation to determine whether a permit is needed. Bottom barriers are not feasible for Balsam Lake because the area requiring management is large.

Weed rollers or 'Automated Unintended Aquatic Plant Control Devices' are motor-drive rollers (round bars) placed on the lake bottom and roll over and uproot plants. The rollers are 25-to-30 feet long and are centered on the end post of a dock. The rollers roll in a circular pattern, normally covering 270^0 or using a 25-foot roller over a full circular area. Weed rollers would be appropriate for controlling aquatic plant nuisances in small areas such as adjacent to a boat dock or for small swimming areas. The rollers are an effective non-chemical control using a simple technology. However, weed rollers cause harm to fisheries and invertebrate habitat. Consequently, use of rollers in Wisconsin lakes is not allowed.

Sediment inactivation has included the application of substances to sediments (i.e., such as lime slurry) that affect the nitrogen and phosphorus composition of the sediments. The growth of aquatic plants is inhibited by the reduced availability of phosphorus or a change in nitrogen in the sediments (Barr, 1997). Lime slurry is also believed to cause carbon limitation by reducing the quantity of carbon available for plants. Lime slurry is an experimental tool currently the subject of a research project by the Eau Galle Aquatic Ecology Laboratory. Use of lime slurry is a feasible option for Balsam Lake and is recommended for consideration in the lake's APM Plan.

5.5.2 Mechanical

Mechanical control involves aquatic plant removal via harvesting, handpulling, hand-digging, rotovation/cultivation, or diver-operated suction dredging. Small scale harvesting may involve the use of the hand or hand-operated equipment such as rakes, cutting blades, or motorized trimmers. Individual residents frequently clear swimming areas via small scale harvesting or hand pulling or hand digging. Small scale harvesting is not a feasible option for Balsam Lake. Although the area requiring management is small in comparison to the total area of the lake containing plants, the area is too large for management by small scale methods.

Large-scale mechanical control often uses floating, motorized harvesting machines that cut the plants and remove them from the water onto land, where they can be disposed. Harvesting has not proven to be an effective means of sustaining long-term reductions in plants such as coontail and Eurasian watermilfoil (EWM) that grow from fragments. Fragments from harvesting may cause coontail or EWM to regrow to preharvest levels or to spread to new areas and increase coverage of these species within a lake. District Board members have indicated that herbicide treatment of Balsam Lake navigation channels during the past few years has been more effective than the harvesting of navigation channels completed in previous years. Hence, harvesting is not a feasible option for Balsam Lake because fragments from harvesting coontail increase coontail coverage within the lake.

Rotovation/cultivation (underwater rototilling) are bottom tillage methods that remove aquatic plant root systems. This results in reduced stem development and seriously impairs growth of rooted aquatic plants. Derooting methods were developed by aquatic plant experts with the British Columbia Ministry of Environment as a more effective EWM control alternative to harvesting. Essentially two types of tillage machinery have been developed. Deep water tillage is performed in water depths of 1.5 to 11.5 feet using a barge-mounted rototiller equipped with a 6-10 foot wide rotating head. Cultivation in shallow water depths up to a few meters is accomplished by means of an amphibious tractor or modified WWII "DUCW" vehicle towing a cultivator. Both methods involve tilling the sediment to a depth of 4-6 inches, which dislodges plants including roots. Certain plants like EWM have roots that are buoyant and float on the surface where they can be collected. Treatments are made in an overlapping swath pattern. Bottom tillage is usually performed in the cold "off-season" months of winter and spring to reduce plant growth potential.

Bottom tillage has been used effectively for long-term control of EWM where populations are well-established and prevention of stem fragments is not critical. Single treatments using a crisscross pattern have resulted in EWM stem density reductions of 80-97 percent in bottom tillage treatments (Gibbons et al. 1987 and Maxnuk 1979). Depending on plant density, carryover effectiveness of rototilling can persist for up to 2 to 3 years without retreatment. Following treatment, rotovated areas in Washington and British Columbia have shown increases in species diversity of native plants, of potential benefit to fisheries (Gibbons 1994). Rototilling is not advised where bottom sediments have excessive nutrient and/or metals concentrations, because of potential release of contaminants into the overlying water. The method does result in production of plant fragments, and is not recommended for use in waterbodies with new or sparse EWM infestations or where release of fragments is a concern. Bottom tillage is not a feasible option for Balsam Lake because this method is exclusively used to manage EWM which is not found in Balsam Lake.

Diver dredging utilizes a small barge or boat carrying portable dredges with suction heads that are operated by scuba divers to remove individual rooted plants (including roots) from the sediment. Divers physically dislodge plants with sharp tools. The plant/sediment slurry is then suctioned up and carried back to the barge through hoses operated by the diver. On the barge, plant parts are sieved out and retained for later off-site disposal. The water sediment slurry can be discharged back to the water or piped off-site for upland disposal. Diver dredging can be highly effective under appropriate conditions (Gibbons 1994). Efficiency of removal is dependent on sediment conditions, density of aquatic plants and underwater visibility (Cooke et al. 1993). As it is best used for localized infestations of low plant density where fragmentation must be minimized, the technique has great potential for milfoil control. Depending on local conditions, milfoil removal efficiencies of 85-97 percent can be achieved by diver dredging (Maxnuk 1979). Diver dredging is not feasible for Balsam Lake because it is exclusively used to control EWM, which is not found in Balsam Lake.

5.5.3 Chemical

Chemical aquatic vegetation management programs are widespread, being the preferred method of control in many areas. Chemical control involves the use of a herbicide (i.e., a plant-killing chemical) that is applied in liquid, granular, or pellet form. Herbicides are of two types, systemic herbicides and contact herbicides. Systemic herbicides, such as 2, 4-D, fluoridone, and glyphosate, are absorbed by and translocated throughout the plant, capable of killing the entire plant (roots and shoots). In contrast, contact herbicides, such as diquat and endothall, kill the plant surface with which it comes in contact, leaving roots alive and capable of regrowth. The aquatic plants (sometimes only stems and leaves) die and decompose in the lake. To reduce human exposure to the chemicals, temporary water-use restrictions are imposed in treatment areas whenever herbicides are used. Only herbicides for aquatic use are allowed, and any use of a herbicide requires a WDNR permit. Use of the contact herbicide Diquat (Reward) is feasible for Balsam Lake.

5.5.4 Biological

Biological control involves the use of a biological control agent to control aquatic plant growth. Biological controls include predation by herbivorous fish, mammals, waterfowl, insects and other invertebrates, diseases caused by microorganisms and competition from other aquatic plants (Little, 1968). The most widely used biological control agent is herbivorous fish, particularly grass carp. Use of grass carp as a biological control agent is not allowed in Wisconsin. Weevils have been used experimentally to control EWM (Creed, et al., 1995; Newman, et al., 1995; Newman 1999). However, since EWM is not found in Balsam Lake, weevils are not a feasible aquatic plant management alternative.

Mechanical, physical, and chemical aquatic plant control techniques and estimated costs are summarized in Table 5. The costs are somewhat dated (i.e., based upon 1997 dollars), but provide a relative cost comparison between the various techniques.

Table 5 Control Techniques for Aquatic Plants: Procedure, Cost, Advantages and Disadvantages (Modified from a Summary Prepared by the Vermont DNR in 1997)

Control Technique	Procedure	Cost	Advantages	Disadvantages
Mechanical and Physical Removal			+Immediate plant removal and creation of open water +No interference with water supplies or water-use	— Creates plant fragments – Usually disturbs sediments, affecting biota and causing short-term turbidity – Plant disposal necessary
Harvesting	Plant stems and leaves cut up to 8 ft below water surface, collected and removed from lake	Cut from 1 to 2 ac/day @ $1,200/day New machine: $80,000-100,000+	+Relatively low operational cost	– Can get regrowth within 4 weeks – Removes small fish, turtles, etc. – Plant fragments may cause spread of Eurasian watermilfoil
Hydro-raking	Mechanical rake removes plants up to 14 ft below water surface and deposits them on shore	Rake up to 1 ac/day @ $1,500–$2,000/ac	+Longer lasting control than harvesting because of root removal	– Regrowth by end of growing season
Rotovating	Sediment is "tilled" to a depth of 4"-6" to dislodge plant roots and stems Can work in depths up to 17 ft	Can do up to 2-3 ac/day @$700–$1,200/ac Cost of new machine is $100,000+	+Immediate 85% – 95% decrease in stem density +Up to 2 years control +Frequently done in fall when plant fragments not viable	
Hydraulic Dredging	Steel cutter blade dislodges sediment and plants; removed by a suction pump	$2,500/ac and up Cost of new machine is $100,000+	+90% effective at root removal, with plant regrowth probable within 1 year	– Expensive

Table 5 Control Techniques for Aquatic Plants: Procedure Cost, Advantages, Disadvantages (Modified from a Summary Prepared by the Vermont DNR in 1997) (Continued)

Control Technique	Procedure	Cost	Advantages	Disadvantages
Diver-operated Suction Harvesting	Scuba divers use 4" suction hose to selectively remove plants from lake bottom Plants disposed of on shore	Cost is \$800–\$10,000/ac depending on cost of divers, type of sediments, travel time, etc. Cost of new machine \$20,000+	+Up to 97% effective at removing plant roots and stems +1–2 years of control +Can work in areas with underwater obstruction	– Effectiveness varies greatly with type of sediment – Slow and labor intensive – Expensive – Potentially hazardous because of scuba
Handpulling	Plants and roots are removed by hand using snorkeling and wading Plants disposed of on shore	Variable, depending on volunteers; divers cost \$15-\$60/hr	+Most effective on newly established populations of EWM that are scattered in density +Volunteers can keep cost down +Long term control if roots removed	– Too slow and labor intensive to use on large scale – Short-term turbidity makes it difficult to see remaining plants
Chemical Treatment			+ Doesn't interfere with underwater obstructions	– Affects water-use; can be toxic to biota – Plants remain in lake and decompose, which can cause oxygen depletion late in the season
2,4-D (Aquakleen, Aquacide, Navigate)	Systemic herbicide available in liquid and pellet form that kills plants by interfering with cell growth and division Can be applied at surface or subsurface in early spring as soon as plants start to grow, or later in the season	\$350–\$700/ac depending on plant density and water depth; cost does not include collection or analysis of water samples, which may be required	+Under favorable conditions can see up to 100% decrease +Kills roots and root crowns +Fairly selective for EWM	– Plants decompose over 2-3 weeks

Table 5 Control Techniques for Aquatic Plants: Procedure Cost, Advantages, Disadvantages (Modified from a Summary Prepared by the Vermont DNR in 1997) (Continued)

Control Technique	Procedure	Cost	Advantages	Disadvantages
Tripclopyr (Garlon 3A)	Liquid systemic herbicide that kills plants by interfering with hormones that regulate normal plant growth	$75/gal or $1200-$1700/ac, depending on water depth, concentration of chemical, etc.	+Effectively removes up to 99% of EWM biomass 4 weeks after treatment +Fast-acting herbicide +Kills roots and root crowns +Fairly selective for EWM	– No domestic-use of water within 1 mile of treated area for 21 days after treatment – No fishing in treated area for 30 days after treatment – Expensive
Fluridone (Sonar)	Systemic herbicide available in liquid and pellet form that inhibits a susceptible plant's ability to make food Can be applied to surface or subsurface in early spring as soon as plants start to grow	$500-$1500/ac depending on water depth and formulation	+Can be applied near water intakes if concentration is less than 20 ppb +Under favorable conditions susceptible species may decrease 100% after 6-10 weeks +Control lasts 1-2 years depending supplemental hand removal +Because slow-acting, low oxygen generally not a problem	– Long contact time required; may take up to 3 months to work – Potential risk to human health remains controversial – Not selective for milfoil – Spot treatments generally not effective
Endothall (Aquathol and Aquathol K)	Granular (Aquathol) and liquid (Aquathol K) kills plants on contact by interfering with protein synthesis Can be applied to surface or subsurface when water temperature is at least 65°F	$300-$700/ac depending on treatment area and use of adjuvants	+Under favorable conditions can see up to 100% decrease +Fast-acting herbicide	– Regrowth within 30 days – Not selective for milfoil – Does not kill roots; only leaves and stems that it contacts – No swimming for 24 h, no fishing for 3 days

Table 5 Control Techniques for Aquatic Plants: Procedure Cost, Advantages, Disadvantages (Modified from a Summary Prepared by the Vermont DNR in 1997) (Continued)

Control Technique	Procedure	Cost	Advantages	Disadvantages
Diquat (Reward)	Liquid kills plants on contact by interfering with photosynthesis Can be applied to surface or subsurface when water temperature is at least 65°F	\$200-\$500/ac	+Fast-acting herbicide +Relatively cheap per acre	– Retreatment within same season may be necessary – Not selective for milfoil – Does not kill roots; only leaves and stems that it contacts – No swimming for 24 h, no drinking for 14 days – Toxic to wildlife

5.6 Balsam Lake Aquatic Plant Management Plan

The Balsam Lake Aquatic Plant Management (APM) Plan outlines management practices required to attain and sustain the lake's beneficial uses. Approximately 94% of the lake's littoral area (i.e., area where plants grow) does not require management because beneficial uses have been attained and are sustained by the lake's current plant community. The following APM Plan describes management practices to attain and sustain the lake's beneficial uses within the small fraction of the lake's littoral area requiring treatment (about 6%). The APM Plan is divided into 2 sections

- Annual Maintenance Program

- Long-Term Improvement Program

5.6.1 Annual Maintenance Program

The annual maintenance program will sustain the lake's beneficial uses by treatment of swimming beaches, boat landings, and navigation channels each year. The program is a nuisance relief program and long-term change is not an expected result of this program. Program details follow.

1) Inspect all boat landings and swimming beaches (See Figure 19) each June and August to identify areas in need of herbicide treatment. how measured?

2) If inspection results indicate treatment is needed in one or more areas, treat these areas with Reward at a dose of 2 gallons per acre. Based upon treatment records during 2002 through 2005, a treatment area of 0.55 is estimated if all five boat landings are treated.

3) If inspection results indicate that treatment at one or more areas is not warranted or if the owner of a private beach or boat landing requests that no treatment be made, then no treatment will occur at these areas.

4) Inspect the lake's navigation channels each June and August to identify areas in need of herbicide treatment. Navigation channels are shown on Figure 19.
how measured?

5) If inspection results indicate that treatment of navigation channels is warranted, treat areas that warrant treatment with Reward at a dose of 2 gallons per acre. Based upon treatment records during 2002 through 2005, a treatment area of approximately 13.5 acres is estimated. This estimated treatment area represents approximately one third of the area covered by navigation channels within the lake.

6) If inspection results indicate that treatment of one or more navigation channels is not warranted, treatment will not occur in areas that do not warrant treatment.

5.6.2 Long-Term Improvement Program

While the annual maintenance program is not expected to result in long-term change, the goal of the long-term improvement program is long-term change. While the annual maintenance program uses a common herbicide, Reward, the long-term improvement program uses an experimental tool, lime slurry. Because all areas within the long-term improvement program are located within fisheries and wildlife sensitive areas, management within these areas is restricted by the WDNR to protect fisheries habitat. Lime slurry is the appropriate management tool for this area because it effectively reduces plant density while preserving native species and protecting fisheries habitat.

The long-term improvement program is comprised of a series of projects to reduce plant density, including curlyleaf pondweed density, to attain favorable long-term changes in problematic areas. Program details follow.

1) Lime slurry will initially be used to treat small test plots within areas 1 and 2 (See Figure 18). Treatment areas will contain curlyleaf pondweed and a plant density of at least 3.5 or greater (i.e., at least 70 percent of the rake head covered). This initial test project will determine whether curlyleaf pondweed can be reduced in these problematic areas and whether the native plant community can be limited to a moderate density. The project is tentatively scheduled for completion during 2007.

How will be success measured?

2) Following successful completion of the small scale project in number 1, areas 1, 2, 3, and 4 (See Figure18) and any other areas of the lake with a plant density of 3.5 or greater will be treated with lime slurry. The estimated treatment area is 33 acres. The project will be evaluated to determine reduction in curlyleaf pondweed density and/or native plant density. The treatment goal is to reduce curlyleaf pondweed to the greatest extent possible and/or to reduce plant density from 3.5 or greater to 2.5 or less. If the results of the small scale project are different than expected, warranted changes or cancellation of this project may occur.

3) Following successful treatment of areas 1, 2, 3, and 4 and any other areas with a plant density of 3.5 or greater, lime slurry will be used to treat selected navigation channels (See Figure 19). The results of the treatment will be evaluated to determine whether lime slurry is a more effective or less costly treatment tool than Reward. Lime slurry will be considered a more effective tool than Reward if treatment frequency is reduced, a moderate plant density is attained, or curlyleaf pondweed density is reduced by the treatment. If the results of the project outlined in number 2 are different than expected, warranted changes or cancellation of this project may occur.

4) Following successful treatment of selected navigation channels, lime slurry will be used for the lake's annual maintenance program (i.e., to treat boat landings, swimming beaches, and navigation channels, see Figure 19). The results of the treatment will be evaluated to determine whether lime slurry is a more effective or less costly treatment tool than Reward. Evaluation of the results will determine whether Reward or lime will be used in the future for the lake's annual maintenance program. Dose, timing of treatment, and treatment frequency will be determined from results of the project outlined in number 3. If less frequent treatment, such as biennial treatment, is required to attain management goals, treatment frequency of the maintenance program will be reduced. If the results of the project outlined in number 3 are different than expected, warranted changes or cancellation of this project may occur.

5.7 Balsam Lake Treatment Effectiveness Monitoring Program

An evaluation program is recommended to monitor the effectiveness of the treatment outlined in the Balsam Lake APM Plan. The evaluation program consists of 2 separate monitoring programs. One evaluation program assesses the lake's annual maintenance program and a second evaluation program assesses the lake's long-term improvement program.

5.7.1 Evaluation of Annual Maintenance Program

An aquatic plant survey will be completed once every 5 years to evaluate the lake's aquatic plant community and to identify warranted changes in the lake's annual maintenance program. The sample locations and methodology used for the 1999 and 2005 aquatic plant surveys will be used for each subsequent plant survey. Survey results will be compared with results from previous surveys to determine changes in the aquatic plant community. Survey results will indicate the health of the plant community and identify any changes that may have occurred. Survey results will identify needed modifications of the annual maintenance program should modification be warranted. If no changes occur in the aquatic plant community and no change in the annual maintenance program is warranted, the annual maintenance program will continue unchanged.

5.7.2 Evaluation of Long-Term Improvement Program

The long-term improvement program involves the use of lime slurry, an experimental tool that is currently the focus of a U.S. Army Corps of Engineers (USACOE) research project. It is anticipated that use of lime slurry in Balsam Lake will occur as a part of a larger USCOE research project. Consequently, the monitoring details of the evaluation program are expected to be determined by the USACOE and are expected to be consistent with the larger research project. Annual monitoring of treated areas is expected and both pre-treatment and post-treatment monitoring is expected to occur each year.

Documentation
of Army Corps
project support?

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2005 Balsam Lake Macrophyte Frequency of Occurrence, Relative Frequency of Occurrence and Diversity (June)

Sample Date: June 23-24, 2005

Species Name	Frequency of Occurrence	rf	rf/100	(rf/100)^2
coontail	89	14.25	0.143	0.02032
Robbins' pondweed	63	10.09	0.101	0.01018
flatstem pondweed	63	10.09	0.101	0.001
Canada waterweed	58	9.21	0.092	0.00848
wild celery	56	8.99	0.090	0.00808
northern watermilfoil	49	7.89	0.079	0.00623
Richardson's pondweed	49	7.89	0.079	0.001
curlyleaf pondweed	41	6.58	0.066	0.00433
water stargrass	32	5.04	0.050	0.00254
largeleaf pondweed	29	4.61	0.046	0.00212
star duckweed	23	3.73	0.037	0.000
spatterdock	15	2.41	0.024	0.000
water crowfoot	15	2.41	0.024	0.00058
narrow leaf pondweed	12	1.97	0.020	0.00039
white waterlily	11	1.75	0.018	0.000
Illinois pondweed	7	1.10	0.011	0.00012
muskgrass	5	0.88	0.009	0.00008
spikerush	3	0.44	0.004	0.00002
bushy naiad	1	0.22	0.002	0.00000
stonewort	1	0.22	0.002	0.00000
floatingleaf pondweed	1	0.22	0.002	0.00000
TOTAL	624.6575342	100.00	1.000	0.06608
	Diversity = 1 - sum of (rf/100)^2		**Diversity**	**0.93392**

2005 Balsam Lake Aquatic Plant Survey
Total Plant Density

Transect	Depth	Rake Toss	Total Plant Density
1a	8	1	2
1a	8	2	2
1a	8	3	2
1a	8	4	2
1b	6	1	1
1b	6	2	1
1b	6	3	1
1b	6	4	1
1c	3.5	1	1
1c	3.5	2	1
1c	3.5	3	1
1c	3.5	4	1
2a	8.5	1	1
2a	8.5	2	2
2a	8.5	3	1
2a	8.5	4	3
2b	4.5	1	1
2b	4.5	2	1
2b	4.5	3	2
2b	4.5	4	1
2c	2	1	1
2c	2	2	0
2c	2	3	0
2c	2	4	1
3a	8	1	1
3a	8	2	1
3a	8	3	1
3a	8	4	3
3b	2.5	1	1
3b	2.5	2	0
3b	2.5	3	1
3b	2.5	4	1
3c	4	1	1
3c	4	2	2
3c	4	3	4
3c	4	4	4
4a	9	1	1
4a	9	2	2
4a	9	3	1
4a	9	4	2
4a	4.5	1	1
4b	4.5	2	3
4b	4.5	3	4
4b	4.5	4	5
4c	2	1	1
4c	2	2	1
4c	2	3	1
4c	2	4	3

2005 Balsam Lake Aquatic Plant Survey

Total Plant Density

Transect	Depth	Rake Toss	Total Plant Density
5a	3.5	1	1
5a	3.5	2	1
5a	3.5	3	3
5a	3.5	4	2
5b	6	1	3
5b	6	2	3
5b	6	3	3
5b	6	4	4
5c	6.5	1	4
5c	6.5	2	4
5c	6.5	3	3
5c	6.5	4	2
5d	7.5	1	1
5d	7.5	2	2
5d	7.5	3	3
5d	7.5	4	4
5e	4	1	1
5e	4	2	1
5e	4	3	1
5e	4	4	1
6a	4.5	1	2
6a	4.5	2	3
6a	4.5	3	2
6a	4.5	4	2
6b	8.5	1	4
6b	8.5	2	4
6b	8.5	3	4
6b	8.5	4	4
6c	11	1	3
6c	11	2	3
6c	11	3	4
6c	11	4	1
6d	5	1	2
6d	5	2	4
6d	5	3	4
6d	5	4	4
6e	2.5	1	4
6e	2.5	2	2
6e	2.5	3	3
6e	2.5	4	4
7a	7	1	3
7a	7	2	4
7a	7	3	3
7a	7	4	3
7b	6	1	3
7b	6	2	4
7b	6	3	3
7b	6	4	5

2005 Balsam Lake Aquatic Plant Survey
Total Plant Density

Transect	Depth	Rake Toss	Total Plant Density
7c	4.5	1	3
7c	4.5	2	2
7c	4.5	3	3
7c	4.5	4	3
8a	7	1	2
8a	7	2	2
8a	7	3	3
8a	7	4	2
8b	4	1	1
8b	4	2	0
8b	4	3	2
8b	4	4	2
8c	2.5	1	1
8c	2.5	2	2
8c	2.5	3	1
8c	2.5	4	2
9a	9.5	1	4
9a	9.5	2	3
9a	9.5	3	3
9a	9.5	4	3
9b	7.5	1	1
9b	7.5	2	3
9b	7.5	3	3
9b	7.5	4	2
9c	2	1	1
9c	2	2	1
9c	2	3	0
9c	2	4	1
10a	7	1	1
10a	7	2	1
10a	7	3	1
10a	7	4	3
10b	4	1	2
10b	4	2	4
10b	4	3	2
10b	4	4	1
10c	3	1	1
10c	3	2	2
10c	3	3	1
10c	3	4	1
11a	8	1	4
11a	8	2	3
11a	8	3	3
11a	8	4	3
11b	5.5	1	4
11b	5.5	2	5
11b	5.5	3	4
11b	5.5	4	4

2005 Balsam Lake Aquatic Plant Survey
Total Plant Density

Transect	Depth	Rake Toss	Total Plant Density
11c	3.5	1	5
11c	3.5	2	5
11c	3.5	3	5
11c	3.5	4	5
12a	10	1	2
12a	10	2	2
12a	10	3	3
12a	10	4	2
12b	5	1	2
12b	5	2	2
12b	5	3	3
12b	5	4	3
12c	3	1	1
12c	3	2	2
12c	3	3	3
12c	3	4	2
13a	7	1	3
13a	7	2	3
13a	7	3	2
13a	7	4	3
13b	5	1	4
13b	5	2	4
13b	5	3	3
13b	5	4	4
13c	1.5	1	1
13c	1.5	2	1
13c	1.5	3	1
13c	1.5	4	1
14a	10	1	3
14a	10	2	3
14a	10	3	3
14a	10	4	3
14b	6.5	1	2
14b	6.5	2	5
14b	6.5	3	3
14b	6.5	4	4
14c	3.5	1	4
14c	3.5	2	3
14c	3.5	3	3
14c	3.5	4	4
15a	8.5	1	3
15a	8.5	2	3
15a	8.5	3	3
15a	8.5	4	3
15b	5	1	2
15b	5	2	1
15b	5	3	3
15b	5	4	4

2005 Balsam Lake Aquatic Plant Survey
Total Plant Density

Transect	Depth	Rake Toss	Total Plant Density
15c	5	1	5
15c	5	2	4
15c	5	3	4
15c	5	4	4
15d	4.5	1	2
15d	4.5	2	2
15d	4.5	3	4
15d	4.5	4	5
16a	8	1	3
16a	8	2	3
16a	8	3	3
16a	8	4	2
16b	5	1	2
16b	5	2	3
16b	5	3	3
16b	5	4	4
16c	2	1	1
16c	2	2	1
16c	2	3	2
16c	2	4	2
17a	5	1	2
17a	5	2	3
17a	5	3	3
17a	5	4	4
17b	5	1	2
17b	5	2	1
17b	5	3	1
17b	5	4	2
17c	2.5	1	1
17c	2.5	2	1
17c	2.5	3	2
17c	2.5	4	1
18a	8.5	1	2
18a	8.5	2	2
18a	8.5	3	4
18a	8.5	4	2
18b	5	1	1
18b	5	2	2
18b	5	3	2
18b	5	4	4
18c	5	1	2
18c	5	2	2
18c	5	3	1
18c	5	4	1
18d	3	1	1
18d	3	2	1
18d	3	3	1
18d	3	4	1

2005 Balsam Lake Aquatic Plant Survey
Total Plant Density

Transect	Depth	Rake Toss	Total Plant Density
19a	12	1	2
19a	12	2	2
19a	12	3	3
19a	12	4	2
19b	8	1	1
19b	8	2	1
19b	8	3	1
19b	8	4	1
20a	11.5	1	1
20a	11.5	2	1
20a	11.5	3	1
20a	11.5	4	2
20b	8	1	1
20b	8	2	2
20b	8	3	2
20b	8	4	1
20c	4.5	1	1
20c	4.5	2	1
20c	4.5	3	1
20c	4.5	4	1
21a	10	1	1
21a	10	2	2
21a	10	3	3
21a	10	4	3
21b	8	1	1
21b	8	2	2
21b	8	3	4
21b	8	4	3
21c	3.5	1	1
21c	3.5	2	4
21c	3.5	3	2
21c	3.5	4	1
22a	9	1	1
22a	9	2	1
22a	9	3	2
22a	9	4	1
22b	6	1	1
22b	6	2	1
22b	6	3	1
22b	6	4	1
23a	6	1	1
23a	6	2	1
23a	6	3	2
23a	6	4	3
23b	3	1	2
23b	3	2	1
23b	3	3	2
23b	3	4	3

2005 Balsam Lake Aquatic Plant Survey
Total Plant Density

Transect	Depth	Rake Toss	Total Plant Density
23c	2	1	1
23c	2	2	3
23c	2	3	1
23c	2	4	1

2005 Balsam Lake Macrophyte Survey
Low, Average, and High Density of Individual Species

Species (Scientific Name)	Species (Common name)	Average Density Per Sample Point	Low Density	High Density
Ranunculus spp.	water crowfoot	1.14	0.25	3.25
Ceratophyllum demersum	coontail	1.06	0.25	5
Potamogeton robbinsii	Robbins' pondweed	0.97	0.25	4
Lemna trisulca	star duckweed	0.85	0.25	2.75
Nymphaea tuberosa	white waterlily	0.81	0	2.5
Elodea canadensis	Canada waterweed	0.81	0.25	3
Potamogeton sp.	narrow leaf pondweed	0.81	0.25	1.25
Potamogeton amplifolius	largeleaf pondweed	0.79	0	2
Nuphar variegata	spatterdock	0.70	0	2
Potamogeton crispus	curlyleaf pondweed	0.63	0	2.75
Myriophyllum sibiricum	northern watermilfoil	0.63	0.25	2.75
Vallisneria americana	wild celery	0.57	0.25	1
Zosterella dubia	water stargrass	0.51	0.25	2
Eleocharis spp.	spikerush	0.50	0.25	0.75
Potamogeton richardsonii	Richardson's pondweed	0.42	0	1.25
Potamogeton zosteriformis	flatstem pondweed	0.39	0	1
Chara spp.	muskgrass	0.38	0.25	0.75
Potamogeton illinoensis	Illinois pondweed	0.30	0.25	0.5
Najas flexilis	bushy naiad	0.25	0.25	0.25
Nitella spp.	stonewort	0.25	0.25	0.25
Potamogeton natans	floatingleaf pondweed	0.00	0	0

Balsam Lake June 23 and 24, 2005

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
1	14-15													
1a		8.0	C	silt	POIL	*Potamogeton illinoensis*	Illinois pondweed	1				0.25		1
1a		8.0	C	silt	VAAM	*Vallisneria americana*	wild celery	1			1	0.50		1
1a		8.0	C	silt	CEDE	*Ceratophyllum demersum*	coontail	1	1	1	1	1.00		1
1a		8.0	C	silt	POSP3	*Potamogeton sp.*	narrow leaf pondweed	1		1		0.50		1
1a		8.0	C	silt	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1	1		0.75		1
1a		8.0	C	silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1	1		0.50		1
1a		8.0	C	silt	PORI	*Potamogeton richardsonii*	claspingleaf pondweed			1	1	0.50		1
1a		8.0	C	silt	PORO	*Potamogeton robbinsii*	Robbins' pondweed			1	1	0.50		0
1a		8.0	C	silt	ELCA	*Elodea canadensis*	Canada waterweed				1	0.25		1
1b		6.0	C	silt, sand, gravel	CEDE	*Ceratophyllum demersum*	coontail	1	1	1	1	1.00		1
1b		6.0	C	silt, sand, gravel	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1		1		0.50		0
1b		6.0	C	silt, sand, gravel	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1			1	0.50		1
1b		6.0	C	silt, sand, gravel	ELCA	*Elodea canadensis*	Canada waterweed	1			1	0.50		1
1b		6.0	C	silt, sand, gravel	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1	1			0.50		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

1b		6.0	C	silt, sand, gravel	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1	1		0.75		1
1b		6.0	C	silt, sand, gravel	VAAM	*Vallisneria americana*	wild celery	1			1	0.50		1
1b		6.0	C	silt, sand, gravel	POSP3	*Potamogeton sp.*	narrow leaf pondweed		1			0.25		1
1b		6.0	C	silt, sand, gravel	ZODU	*Zosterella dubia*	water stargrass			1		0.25		1
1c		3.5	B	sand,grav el	VAAM	*Vallisneria americana*	wild celery	1	1	1	1	1.00		1
1c		3.5	B	sand,grav el	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1			1	0.50		1
1c		3.5	B	sand,grav el	CEDE	*Ceratophyllum demersum*	coontail				1	0.25		1
2	15													
2a		8.5	C	muck,sand	CEDE	*Ceratophyllum demersum*	coontail	1	1		1	0.75		1
2a		8.5	C	muck,sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1	1	1.00		0
2a		8.5	C	muck,sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1		1	1	0.75		1
2a		8.5	C	muck,sand	ELCA	*Elodea canadensis*	Canada waterweed		1	1	2	1.00		1
2a		8.5	C	muck,sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1			0.25		1
2a		8.5	C	muck,sand	RASP	*Ranunculus spp.*	water crowfoot		1	1		0.50		0
2a		8.5	C	muck,sand	POSP3	*Potamogeton sp.*	narrow leaf pondweed		1	1		0.50		1
2a		8.5	C	muck,sand	VAAM	*Vallisneria americana*	wild celery			1		0.25		1
2b		4.5	B	sand	POCR	*Potamogeton crispus*	curlyleaf pondweed	1				0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
2b		4.5	B	sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1				0.25		1
2b		4.5	B	sand	POAM	*Potamogeton amplifolius*	largeleaf pondweed	1		1	1	0.75		1
2b		4.5	B	sand	ZODU	*Zosterella dubia*	water stargrass	1.00	1.00		1.00	0.75		1
2b		4.5	B	sand	ELCA	*Elodea canadensis*	Canada waterweed	1.00		1.00	1.00	0.75		1
2b		4.5	B	sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1.00	1.00	1.00		0.75		1
2b		4.5	B	sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed		1.00			0.25		1
2b		4.5	B	sand	CEDE	*Ceratophyllum demersum*	coontail		1.00	1.00	1.00	0.75		1
2b		4.5	B	sand	VAAM	*Vallisneria americana*	wild celery		1.00			0.25		1
2c		2.0	B	sand,grav el	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1.00				0.25		1
2c		2.0	B	sand,grav el	VAAM	*Vallisneria americana*	wild celery				1.00	0.25		1
2c		2.0	B	sand,grav el	POAM	*Potamogeton amplifolius*	largeleaf pondweed					0.00	X	1
3	13													
3a		8.0	C	silt, sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1.00	1.00	1.00	1.00	1.00		1
3a		8.0	C	silt, sand	ELCA	*Elodea canadensis*	Canada waterweed	1.00		1.00	3.00	1.25		1
3a		8.0	C	silt,sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1.00				0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake **June 23 and 24, 2005**

3a		8.0	C	silt,sand	VAAM	*Vallisneria americana*	wild celery	1.00	1.00	1.00	1.00	1.00		1
3a		8.0	C	silt,sand	POAM	*Potamogeton amplifolius*	largeleaf pondweed	1.00				0.25		1
3a		8.0	C	silt,sand	CEDE	*Ceratophyllum demersum*	coontail		1.00	1.00		0.50		1
3a		8.0	C	silt,sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1.00			0.25		0
3a		8.0	C	silt,sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil				1.00	0.25		1
3a		8.0	C	silt,sand	POCR	*Potamogeton crispus*	curlyleaf pondweed				1.00	0.25		1
3b		2.5	B	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1.00	1.00			0.50		0
3b		2.5	B	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1.00				0.25		1
3b		2.5	B	muck	NYTU	*Nymphaea tuberosa*	white waterlily					0.00	X	2
3b		2.5	B	muck	CEDE	*Ceratophyllum demersum*	coontail		1.00		1.00	0.50		1
3b		2.5	B	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed			1.00	1.00	0.50		1
3b		2.5	B	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed				1.00	0.25		1
3b		2.5	B	muck	POAM	*Potamogeton amplifolius*	largeleaf pondweed					0.00	X	1
3c		4.0	B	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1.00	2.00	4.00	4.00	2.75		0
3c		4.0	B	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1.00				0.25		1
3c		4.0	B	muck	LETR	*Lemna trisulca*	star duckweed		1.00			0.25		0
3c		4.0	B	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1.00			0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
3c		4.0	B	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1.00			0.25		1
3c		4.0	B	muck	NYTU	*Nymphaea tuberosa*	white waterlily					0.00	X	2
3c		4.0	B	muck	NUVA	*Nuphar variegata*	spatterdock					0.00	X	2
3c		4.0	B	muck	CEDE	*Ceratophyllum demersum*	coontail			1	1	0.50		1
3c		4.0	B	muck	POAM	*Potamogeton amplifolius*	largeleaf pondweed		1	1	1	0.75		1
4	12													
4a		9.0	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed	1	2	1	2	1.50		1
4a		9.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail	1	1	1		0.75		1
4a		9.0	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1	1		1	0.75		1
4a		9.0	C	muck	ELCA	*Elodea canadensis*	Canada waterweed			1	1	0.50		1
4a		9.0	C	muck	LETR	*Lemna trisulca*	star duckweed			1		0.25		0
4b		4.5	B	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	2	3	2	2	2.25		0
4b		4.5	B	muck	CEDE	*Ceratophyllum demersum*	coontail	1	1		1	0.75		1
4b		4.5	B	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1	1		0.75		1
4b		4.5	B	muck	VAAM	*Vallisneria americana*	wild celery	1			1	0.50		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake **June 23 and 24, 2005**

4b		4.5	B	muck	ZODU	*Zosterella dubia*	water stargrass		1		1	0.50		1
4b		4.5	B	muck	ELCA	*Elodea canadensis*	Canada waterweed		1	1	2	1.00		1
4b		4.5	B	muck	RASP	*Ranunculus spp.*	water crowfoot			1		0.25		0
4b		4.5	B	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed					0.00	X	1
4b		4.5	B	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1		1		0.50		1
4c		2.0	B	silt,sand	POCR	*Potamogeton crispus*	curlyleaf pondweed		1			0.25		1
4c		2.0	B	silt,sand	ZODU	*Zosterella dubia*	water stargrass	1	1	1	1	1.00		1
4c		2.0	B	silt,sand	VAAM	*Vallisneria americana*	wild celery	1		1		0.50		1
4c		2.0	B	silt,sand	ELCA	*Elodea canadensis*	Canada waterweed	1		1	1	0.75		1
4c		2.0	B	silt,sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1			1	0.50		1
4c		2.0	B	silt,sand	NUVA	*Nuphar variegata*	spatterdock	1	1	1	1	1.00		2
4c		2.0	B	silt,sand	RASP	*Ranunculus spp.*	water crowfoot	1	1	1	1	1.00		0
4c		2.0	B	silt,sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1		1	0.50		1
4c		2.0	B	silt,sand	CEDE	*Ceratophyllum demersum*	coontail		1	1	1	0.75		1
5														
5a		3.5	B	muck	VAAM	*Vallisneria americana*	wild celery	1		1		0.50		1
5a		3.5	B	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1			0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

5a		3.5	B	muck	ELCA	*Elodea canadensis*	Canada waterweed		1	3	1	1.25		1
5a		3.5	B	muck	ZODU	*Zosterella dubia*	water stargrass		1		1	0.50		1
5a		3.5	B	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1	1		0.50		1
5a		3.5	B	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1	1	1	0.75		1
5a		3.5	B	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil				1	0.25		1
														#N/A

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
5b		6.0	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	3	2	2	2	2.25		0
5b		6.0	C	muck	VAAM	*Vallisneria americana*	wild celery		1	1		0.50		1
5b		6.0	C	muck	ELCA	*Elodea canadensis*	Canada waterweed		1	1	2	1.00		1
5b		6.0	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1			0.25		1
5b		6.0	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed		1	1		0.50		1
5b		6.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail		1	1	1	0.75		1
5b		6.0	C	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed			1		0.25		1
5c		6.5	C	muck	ELCA	*Elodea canadensis*	Canada waterweed	4	1	1	2	2.00		1
5c		6.5	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1			0.25		0

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake **June 23 and 24, 2005**

5c		6.5	C	muck	LETR	*Lemna trisulca*	star duckweed		1			0.25		0
5c		6.5	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed			1	1	0.50		1
5c		6.5	C	muck	CEDE	*Ceratophyllum demersum*	coontail			1		0.25		1
5c		6.5	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed				1	0.25		0
5d		7.5	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	2	2	1	1.50		1
5d		7.5	C	muck	ZODU	*Zosterella dubia*	water stargrass		1			0.25		1
5d		7.5	C	muck	CEDE	*Ceratophyllum demersum*	coontail		1	1	1	0.75		1
5d		7.5	C	muck	POAM	*Potamogeton amplifolius*	largeleaf pondweed		1	1	1	0.75		1
5d		7.5	C	muck	VAAM	*Vallisneria americana*	wild celery		1	1	1	0.75		1
5d		7.5	C	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed			1	1	0.50		1
5d		7.5	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed			1	1	0.50		1
5d		7.5	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed				1	0.25		1
5e		4.0	B	sand,gravel	LETR	*Lemna trisulca*	star duckweed	1			1	0.50		0
5e		4.0	B	sand,gravel	VAAM	*Vallisneria americana*	wild celery	1	1	1	1	1.00		1
5e		4.0	B	sand,gravel	ELCA	*Elodea canadensis*	Canada waterweed		1	1		0.50		1
5e		4.0	B	sand,gravel	CHSP	*Chara spp.*	muskgrass		1			0.25		1
6	15-16													

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C. 5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

6a		4.5	B	silt	POSP3	*Potamogeton sp.*	narrow leaf pondweed	1	1	1	1	1.00		1
6a		4.5	B	silt	POAM	*Potamogeton amplifolius*	largeleaf pondweed	1			1	0.50		1
6a		4.5	B	silt	NYTU	*Nymphaea tuberosa*	white waterlily	1	1	1	1	1.00		2
6a		4.5	B	silt	ELCA	*Elodea canadensis*	Canada waterweed	1	2			0.75		1
6a		4.5	B	silt	CEDE	*Ceratophyllum demersum*	coontail	1		1		0.50		1
6a		4.5	B	silt	LETR	*Lemna trisulca*	star duckweed	1	1	1		0.75		1
6a		4.5	B	silt	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1	1		0.50		1
Transect or Point	**MRD**	**Depth (ft)**	**Depth Code**	**Substrate Type**	**Species Code**	**Species (Scientific Name)**	**Species (Common name)**	**Density Rating Cast # 1**	**Density Rating Cast # 2**	**Density Rating Cast # 3**	**Density Rating Cast # 4**	**Average Density**	**Observed (x)**	**Type[1]**
6a		4.5	B	silt	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1		1	0.50		0
6a		4.5	B	silt	POCR	*Potamogeton crispus*	curlyleaf pondweed		1	1	1	0.75		1
6a		4.5	B	silt	VAAM	*Vallisneria americana*	wild celery			1		0.25		1
6b		8.5	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	4	4	4	4	4.00		0
6b		8.5	C	muck	CEDE	*Ceratophyllum demersum*	coontail	1	1	1		0.75		1
6b		8.5	C	muck	NYTU	*Nymphaea tuberosa*	white waterlily					0.00	X	2
6b		8.5	C	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil				1	0.25		1
6b		8.5	C	muck	CEDE	*Ceratophyllum demersum*	coontail				1	0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

1— . (plant community): 1=submerged. 2=floating-leaf, 3=emergent

Balsam Lake **June 23 and 24, 2005**

6b		8.5	C	muck	ELCA	*Elodea canadensis*	Canada waterweed				1	0.25		1
6c		11.0	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	3	3	2		2.00		0
6c		11.0	C	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1		1	1	0.75		1
6c		11.0	C	muck	ELCA	*Elodea canadensis*	Canada waterweed	1		1	1	0.75		1
6c		11.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail		1	2	1	1.00		1
6c		11.0	C	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed			1	1	0.50		1
6c		11.0	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed			1		0.25		1
6d		5.0	B	silt/sand	NYTU	*Nymphaea tuberosa*	white waterlily	1	2	4	3	2.50		2
6d		5.0	B	silt/sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1		1	1	0.75		1
6d		5.0	B	silt/sand	POAM	*Potamogeton amplifolius*	largeleaf pondweed	1	2	1	1	1.25		1
6d		5.0	B	silt/sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1	1	1.00		0
6d		5.0	B	silt/sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1	1		0.75		1
6d		5.0	B	silt/sand	VAAM	*Vallisneria americana*	wild celery	1	1	1	1	1.00		1
6d		5.0	B	silt/sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1				0.25		1
6d		5.0	B	silt/sand	CHSP	*Chara spp.*	muskgrass	1				0.25		1
6d		5.0	B	silt/sand	NITELLA	*Nitella spp.*	stonewort	1				0.25		0
6d		5.0	B	silt/sand	CEDE	*Ceratophyllum demersum*	coontail		1	1	1	0.75		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
6d		5.0	B	silt/sand	LETR	*Lemna trisulca*	star duckweed			1	1	0.50		0
6e		2.5	B	silt/sand	NYTU	*Nymphaea tuberosa*	white waterlily	2	2	3	1	2.00		2
6e		2.5	B	silt/sand	LETR	*Lemna trisulca*	star duckweed	2	2	3	4	2.75		0
6e		2.5	B	silt/sand	VAAM	*Vallisneria americana*	wild celery	1	1	1	1	1.00		1
6e		2.5	B	silt/sand	ELCA	*Elodea canadensis*	Canada waterweed	1			1	0.50		1
6e		2.5	B	silt/sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1	1	1	1.00		1
6e		2.5	B	silt/sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1		1		0.50		0
6e		2.5	B	silt/sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1				0.25		1
6e		2.5	B	silt/sand	ZODU	*Zosterella dubia*	water stargrass		1			0.25		1
6e		2.5	B	silt/sand	POCR	*Potamogeton crispus*	curlyleaf pondweed				1	0.25		1
7	13-14													
7a		7.0	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1				0.25		1
7a		7.0	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed	1	1			0.50		1
7a		7.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail	3	3	1	3	2.50		1
7a		7.0	C	muck	ELCA	*Elodea canadensis*	Canada waterweed		2	3	3	2.00		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake **June 23 and 24, 2005**

7a		7.0	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed		3	1		1.00		0
7b		6.0	C	silt,muck	ELCA	*Elodea canadensis*	Canada waterweed	2	3	3	4	3.00		1
7b		6.0	C	silt,muck	CEDE	*Ceratophyllum demersum*	coontail	1	3	2	3	2.25		1
7b		6.0	C	silt,muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1		1	1	0.75		1
7b		6.0	C	silt,muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed				1	0.25		0
7b		6.0	C	silt,muck	POAM	*Potamogeton amplifolius*	largeleaf pondweed				1	0.25		1
7c		4.5	B	silt/sand	CEDE	*Ceratophyllum demersum*	coontail	3	2	1	3	2.25		1
7c		4.5	B	silt/sand	ELCA	*Elodea canadensis*	Canada waterweed	2	1	2	1	1.50		1
7c		4.5	B	silt/sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1			0.25		1
7c		4.5	B	silt/sand	POCR	*Potamogeton crispus*	curlyleaf pondweed		1	1	1	0.75		1
7c		4.5	B	silt/sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed					0.00	X	1
8	7													#N/A
8a		7.0	C	sand	POAM	*Potamogeton amplifolius*	largeleaf pondweed	1		3	1	1.25		1
8a		7.0	C	sand	ELCA	*Elodea canadensis*	Canada waterweed	1	1		1	0.75		1
8a		7.0	C	sand	VAAM	*Vallisneria americana*	wild celery	1	1	1		0.75		1
8a		7.0	C	sand	CEDE	*Ceratophyllum demersum*	coontail	1	1	1	2	1.25		1
8a		7.0	C	sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1		1	0.50		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

8a		7.0	C	sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed			1		0.25		1
8b		4.0	B	sand,gravel	CEDE	*Ceratophyllum demersum*	coontail	1				0.25		1
8b		4.0	B	sand,gravel	VAAM	*Vallisneria americana*	wild celery	1		1	1	0.75		1
8b		4.0	B	sand,gravel	POIL	*Potamogeton illinoensis*	Illinois pondweed			1		0.25	X	1
8b		4.0	B	sand,gravel	RASP	*Ranunculus spp.*	water crowfoot			2	2	1.00		1
8c		2.5	B	sand	RASP	*Ranunculus spp.*	water crowfoot	1	2	1	1	1.25		0
8c		2.5	B	sand	ELSP	*Elodea canadensis*	Canada waterweed		1			0.25		1
8c		2.5	B	sand	VAAM	*Vallisneria americana*	wild celery		1	1		0.50		1
8c		2.5	B	sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed				1	0.25		1
8c		2.5	B	sand	CEDE	*Ceratophyllum demersum*	coontail				1	0.25		1
8c		2.5	B	sand	ELCA	*Elodea canadensis*	Canada waterweed				1	0.25		1
8c		2.5	B	sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed				1	0.25		0
														#N/A
9	9.5													#N/A
Transect or Point	**MRD**	**Depth (ft)**	**Depth Code**	**Substrate Type**	**Species Code**	**Species (Scientific Name)**	**Species (Common name)**	**Density Rating Cast # 1**	**Density Rating Cast # 2**	**Density Rating Cast # 3**	**Density Rating Cast # 4**	**Average Density**	**Observed (x)**	**Type[1]**
9a		9.5	C	silt,sand	ELCA	*Elodea canadensis*	Canada waterweed	4	1	1		1.50		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

9a		9.5	C	silt,sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1		0.75		0
9a		9.5	C	silt,sand	CEDE	*Ceratophyllum demersum*	coontail		2	2	3	1.75		1
9a		9.5	C	silt,sand	ZODU	*Zosterella dubia*	water stargrass		1			0.25		1
9a		9.5	C	silt,sand	POIL	*Potamogeton illinoensis*	Illinois pondweed				1	0.25		1
9b		7.5	C	silt,sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1				0.25		1
9b		7.5	C	silt,sand	VAAM	*Vallisneria americana*	wild celery	1				0.25		1
9b		7.5	C	silt,sand	CEDE	*Ceratophyllum demersum*	coontail	1	1	1	1	1.00		1
9b		7.5	C	silt,sand	ZODU	*Zosterella dubia*	water stargrass	1		2		0.75		1
9b		7.5	C	silt,sand	POAM	*Potamogeton amplifolius*	largeleaf pondweed		3	2	2	1.75		1
9b		7.5	C	silt,sand	ELCA	*Elodea canadensis*	Canada waterweed			2		0.50		1
9c		2.0	B	sand,gravel	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1	1			0.50		1
9c		2.0	B	sand,gravel	ZODU	*Zosterella dubia*	water stargrass	1				0.25		1
9c		2.0	B	sand,gravel	VAAM	*Vallisneria americana*	wild celery	1	1			0.50		1
9c		2.0	B	sand,gravel	CHSP	*Chara spp.*	muskgrass				1	0.25		1
10	11.5													1
10a		7.0	C	sand,gravel	CEDE	*Ceratophyllum demersum*	coontail	1	1	1	1	1.00		1
10a		7.0	C	sand,gravel	MYSI	*Myriophyllum sibiricum*	northern watermilfoil				3	0.75		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C. 5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

10a		7.0	C	sand,gravel	POZO	*Potamogeton zosteriformis*	flatstem pondweed				1	0.25		1
10b		4.0	B	sand,gravel	CEDE	*Ceratophyllum demersum*	coontail	2		2	1	1.25		1
10b		4.0	B	sand,gravel	POAM	*Potamogeton amplifolius*	largeleaf pondweed	1	1			0.50		1
10b		4.0	B	sand,gravel	ELCA	*Elodea canadensis*	Canada waterweed		4	1		1.25		1
10b		4.0	B	sand,gravel	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1			0.25		1
10b		4.0	B	sand,gravel	VAAM	*Vallisneria americana*	wild celery			1		0.25		1
10b		4.0	B	sand,gravel	PORI	*Potamogeton richardsonii*	claspingleaf pondweed					0.00	X	1
10c		3.0	B	sand	POIL	*Potamogeton illinoensis*	Illinois pondweed	1				0.25		1
10c		3.0	B	sand	VAAM	*Vallisneria americana*	wild celery	1	1			0.50		1
10c		3.0	B	sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1		1	0.50		0
10c		3.0	B	sand	POAM	*Potamogeton amplifolius*	largeleaf pondweed		1			0.25		1
10c		3.0	B	sand	ZODU	*Zosterella dubia*	water stargrass		1		1	0.50		1
10c		3.0	B	sand	NYTU	*Nymphaea tuberosa*	white waterlily			1		0.25	X	2
10c		3.0	B	sand	CEDE	*Ceratophyllum demersum*	coontail			1		0.25		1
10c		3.0	B	sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed			1		0.25		1
11	11.5													
11a		8.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail	4	3	1	2	2.50		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

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11a		8.0	C	muck	POAM	*Potamogeton amplifolius*	largeleaf pondweed	2		3	1	1.50		1
11a		8.0	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1	1	1	1	1.00		1
Transect or Point	**MRD**	**Depth (ft)**	**Depth Code**	**Substrate Type**	**Species Code**	**Species (Scientific Name)**	**Species (Common name)**	**Density Rating Cast # 1**	**Density Rating Cast # 2**	**Density Rating Cast # 3**	**Density Rating Cast # 4**	**Average Density**	**Observed (x)**	**Type[1]**
11a		8.0	C	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed				2	0.50		1
11b		5.5	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	4		3	1	2.00		1
11b		5.5	C	muck	CEDE	*Ceratophyllum demersum*	coontail	1	5	2	4	3.00		1
11b		5.5	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1			0.25		1
11b		5.5	C	muck	POAM	*Potamogeton amplifolius*	largeleaf pondweed		1	2	2	1.25		1
11b		5.5	C	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed		1			0.25		1
11c		3.5	B	muck	CEDE	*Ceratophyllum demersum*	coontail	5	5	5	5	5.00		1
11c		3.5	B	muck	NYTU	*Nymphaea tuberosa*	white waterlily	1	1	1		0.75		2
11c		3.5	B	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1	1	1.00		0
11c		3.5	B	muck	ELCA	*Elodea canadensis*	Canada waterweed			1		0.25		1
11c		3.5	B	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed			1		0.25		1
12	12.5													#N/A
12a		10.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail	2	1	3	1	1.75		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

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12a		10.0	C	muck	VAAM	*Vallisneria americana*	wild celery		1		1	0.50		1
12a		10.0	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1		1	0.50		0
12a		10.0	C	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1	1	1	0.75		1
12b		5.0	B	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	2	1	2	2	1.75		1
12b		5.0	B	muck	CEDE	*Ceratophyllum demersum*	coontail	1	2		1	1.00		1
12b		5.0	B	muck	NUVA	*Nuphar variegata*	spatterdock		1	2	2	1.25		2
12b		5.0	B	muck	ZODU	*Zosterella dubia*	water stargrass	1	2	2	3	2.00		1
12c		3.0	B	sand	NUVA	*Nuphar variegata*	spatterdock	1	2	3	2	2.00		1
12c		3.0	B	sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1			0.50		1
12c		3.0	B	sand	ELCA	*Elodea canadensis*	Canada waterweed	1				0.25		1
13	14													
13a		7.0	C	silt	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1		0.75		0
13a		7.0	C	silt	CEDE	*Ceratophyllum demersum*	coontail	3	3	1	3	2.50		1
13a		7.0	C	silt	POAM	*Potamogeton amplifolius*	largeleaf pondweed		1	1	2	1.00		1
13a		7.0	C	silt	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1			0.25		1
13a		7.0	C	silt	ELCA	*Elodea canadensis*	Canada waterweed		1			0.25		1
13b		5.0	B	muck	CEDE	*Ceratophyllum demersum*	coontail	4	4	2	3	3.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
13b		5.0	B	muck	POAM	*Potamogeton amplifolius*	largeleaf pondweed	3	1	3	1	2.00		1
13b		5.0	B	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1	1	1	0.75		0
13b		5.0	B	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed			1		0.25		1
13b		5.0	B	muck	ELCA	*Elodea canadensis*	Canada waterweed				1	0.25		1
13b		5.0	B	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed				1	0.25		1
13c		1.5	A	sand,gravel	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1				0.25		0
13c		1.5	A	sand,gravel	ELCA	*Elodea canadensis*	Canada waterweed	1	1	1		0.75		1
13c		1.5	A	sand,gravel	CEDE	*Ceratophyllum demersum*	coontail			1		0.25		1
13c		1.5	A	sand,gravel	VAAM	*Vallisneria americana*	wild celery				1	0.25		1
13c		1.5	A	sand,gravel	POZO	*Potamogeton zosteriformis*	flatstem pondweed				1	0.25		1
13c		1.5	A	sand,gravel	POCR	*Potamogeton crispus*	curlyleaf pondweed				1	0.25		1
14	13.5													
14a		10.0	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed	3	3	3	2	2.75		1
14a		10.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail	1	2	3	1	1.75		1
14a		10.0	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1	1	1	1	1.00		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

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14a		10.0	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1			0.25		0
14b		6.5	C	muck	ELCA	*Elodea canadensis*	Canada waterweed	1	5	2	1	2.25		1
14b		6.5	C	muck	RASP	*Ranunculus spp.*	water crowfoot	1			4	1.25		0
14b		6.5	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1	1	1.00		0
14b		6.5	C	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed				1	0.25	X	1
14c		3.5	B	silt,detritis	NUVA	*Nuphar variegata*	spatterdock	1	2		3	1.50		2
14c		3.5	B	silt,detritis	RASP	*Ranunculus spp.*	water crowfoot	4	3	3	3	3.25		0
14c		3.5	B	silt,detritis	VAAM	*Vallisneria americana*	wild celery	1				0.25		1
14c		3.5	B	silt,detritis	PONA	*Potamogeton natans*	floatingleaf pondweed					0.00	X	2
14c		3.5	B	silt,detritis	CEDE	*Ceratophyllum demersum*	coontail		1	1	1	0.75		1
14c		3.5	B	silt,detritis	ELCA	*Elodea canadensis*	Canada waterweed		1	1	1	0.75		1
14c		3.5	B	silt,detritis	POCR	*Potamogeton crispus*	curlyleaf pondweed					0.00	X	1
15	13.5													
15a		8.5	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	2	1	2	1	1.50		0
15a		8.5	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed	1	2		3	1.50		1
15a		8.5	C	muck	CEDE	*Ceratophyllum demersum*	coontail	1		1	1	0.75		1
15a		8.5	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1				0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
15a		8.5	C	muck	ELCA	*Elodea canadensis*	Canada waterweed		1			0.25		1
15a		8.5	C	muck	RASP	*Ranunculus spp.*	water crowfoot		1			0.25		0
15a		8.5	C	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil			1	1	0.50		1
15a		8.5	C	muck	ELCA	*Elodea canadensis*	Canada waterweed			1	1	0.50		1
15b		5.0	B	muck,detritis	POCR	*Potamogeton crispus*	curlyleaf pondweed	1		2		0.75		1
15b		5.0	B	muck,detritis	PORO	*Potamogeton robbinsii*	Robbins' pondweed	2	1	1	3	1.75		0
15b		5.0	B	muck,detritis	VAAM	*Vallisneria americana*	wild celery	1				0.25		1
15b		5.0	B	muck,detritis	ELCA	*Elodea canadensis*	Canada waterweed			1	1	0.50		1
15b		5.0	B	muck,detritis	POZO	*Potamogeton zosteriformis*	flatstem pondweed				1	0.25		1
15b		5.0	B	muck,detritis	CEDE	*Ceratophyllum demersum*	coontail				1	0.25		1
15c		5.0	B	muck,organi	CEDE	*Ceratophyllum demersum*	coontail	4	3	4	3	3.50		1
15c		5.0	B	muck,organi	PORO	*Potamogeton robbinsii*	Robbins' pondweed	2	1	1	1	1.25		0
15c		5.0	B	muck,organi	POCR	*Potamogeton crispus*	curlyleaf pondweed				1	0.25		1
15c		5.0	B	muck,organi	PORI	*Potamogeton richardsonii*	claspingleaf pondweed				1	0.25		1
15d		4.5	B	muck,detritis	RASP	*Ranunculus spp.*	water crowfoot	2	2	4	5	3.25		0

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

15d		4.5	B	muck,detritis	POCR	*Potamogeton crispus*	curlyleaf pondweed	1				0.25		1
15d		4.5	B	muck,detritis	NUVA	*Nuphar variegata*	spatterdock	1				0.25		2
15d		4.5	B	muck,detritis	CEDE	*Ceratophyllum demersum*	coontail		1			0.25		1
15d		4.5	B	muck,detritis	POZO	*Potamogeton zosteriformis*	flatstem pondweed			1		0.25		1
15d		4.5	B	muck,detritis	MYSI	*Myriophyllum sibiricum*	northern watermilfoil				1	0.25		1
16	12--13													
16a		8.0	C	silt	CEDE	*Ceratophyllum demersum*	coontail	2	3	2		1.75		1
16a		8.0	C	silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1	2		1	1.00		1
16a		8.0	C	silt	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1				0.25		1
16a		8.0	C	silt	POCR	*Potamogeton crispus*	curlyleaf pondweed			2	2	1.00		1
16b		5.0	B	silt,detritis	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1			1	0.50		1
16b		5.0	B	silt,detritis	ELCA	*Elodea canadensis*	Canada waterweed	1		1	4	1.50		1
16b		5.0	B	silt,detritis	ZODU	*Zosterella dubia*	water stargrass	1				0.25		1
16b		5.0	B	silt,detritis	CEDE	*Ceratophyllum demersum*	coontail	1				0.25		1
16b		5.0	B	silt,detritis	RASP	*Ranunculus spp.*	water crowfoot	1				0.25		0
16b		5.0	B	silt,detritis	POAM	*Potamogeton amplifolius*	largeleaf pondweed		1			0.25		1
16b		5.0	B	silt,detritis	CEDE	*Ceratophyllum demersum*	coontail		3	3		1.50		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake **June 23 and 24, 2005**

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
16b		5.0	B	silt,detritis	VAAM	*Vallisneria americana*	wild celery			1		0.25		1
16b		5.0	B	silt,detritis	PORI	*Potamogeton richardsonii*	claspingleaf pondweed			1		0.25		1
16c		2.0	B	sand,gravel	NUVA	*Nuphar variegata*	spatterdock	1	1	1	1	1.00		2
16c		2.0	B	sand,gravel	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1	1	1	1.00		1
16c		2.0	B	sand,gravel	POCR	*Potamogeton crispus*	curlyleaf pondweed		1			0.25		1
16c		2.0	B	sand,gravel	ZODU	*Zosterella dubia*	water stargrass		1			0.25		1
16c		2.0	B	sand,gravel	CEDE	*Ceratophyllum demersum*	coontail			2	1	0.75		1
16c		2.0	B	sand,gravel	VAAM	*Vallisneria americana*	wild celery			1		0.25		1
16c		2.0	B	sand,gravel	ZODU	*Zosterella dubia*	water stargrass			1	1	0.50		1
17	15													
17a		5.0	B	silt	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	2	2	3	4	2.75		1
17a		5.0	B	silt	ZODU	*Zosterella dubia*	water stargrass	1				0.25		1
17a		5.0	B	silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1		1		0.50		1
17a		5.0	B	silt	POSP3	*Potamogeton sp.*	narrow leaf pondweed	1	1			0.50		1
17a		5.0	B	silt	CEDE	*Ceratophyllum demersum*	coontail		1			0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

17a		5.0	B	silt	PORI	*Potamogeton richardsonii*	Richardson's pondweed		1		1	0.50		1
17a		5.0	B	silt	VAAM	*Vallisneria americana*	wild celery		1	1	1	0.75		1
17a		5.0	B	silt	POCR	*Potamogeton crispus*	curlyleaf pondweed			1	1	0.50		1
17b		5.0	B	n/a	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1	2	1.25		0
17b		5.0	B	n/a	LETR	*Lemna trisulca*	star duckweed	1		1		0.50		0
17b		5.0	B	n/a	CEDE	*Ceratophyllum demersum*	coontail	1	1	1	1	1.00		1
17b		5.0	B	n/a	PORI	*Potamogeton richardsonii*	claspingleaf pondweed			1		0.25		1
17b		5.0	B	n/a	POCR	*Potamogeton crispus*	curlyleaf pondweed				1	0.25		1
17b		5.0	B	n/a	MYSI	*Myriophyllum sibiricum*	northern watermilfoil				1	0.25		1
17c		2.5	B	silt,sand	VAAM	*Vallisneria americana*	wild celery	1				0.25		1
17c		2.5	B	silt,sand	CEDE	*Ceratophyllum demersum*	coontail	1			1	0.50		1
17c		2.5	B	silt,sand	LETR	*Lemna trisulca*	star duckweed		1	2		0.75		0
17c		2.5	B	silt,sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1	1		0.50		1
17c		2.5	B	silt,sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed				1	0.25		0
17c		2.5	B	silt,sand	VAAM	*Vallisneria americana*	wild celery				1	0.25		1
17c		2.5	B	silt,sand	NUVA	*Nuphar variegata*	spatterdock					0.00	X	2
18	14-15													

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake **June 23 and 24, 2005**

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
18a		8.5	C	sand,silk	CEDE	*Ceratophyllum demersum*	coontail	2	1		1	1.00		1
18a		8.5	C	sand,silk	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1	1		1	0.75		1
18a		8.5	C	sand,silk	ELCA	*Elodea canadensis*	Canada waterweed	1		2	1	1.00		1
18a		8.5	C	sand,silk	POCR	*Potamogeton crispus*	curlyleaf pondweed	1			1	0.50		1
18a		8.5	C	sand,silk	PORO	*Potamogeton robbinsii*	Robbins' pondweed		1			0.25		1
18a		8.5	C	sand,silk	RASP	*Ranunculus spp.*	water crowfoot		1			0.25		0
18a		8.5	C	sand,silk	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1		1	0.50		1
18a		8.5	C	sand,silk	PORI	*Potamogeton richardsonii*	Richardson's pondweed			1	1	0.50		1
18a		8.5	C	sand,silk	ELCA	*Elodea canadensis*	Canada waterweed			2		0.50		1
18b		5.0	B	sand	LETR	*Lemna trisulca*	star duckweed	1	2	2	1	1.50		0
18b		5.0	B	sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1		1	0.75		0
18b		5.0	B	sand	VAAM	*Vallisneria americana*	wild celery	1	1			0.50		1
18b		5.0	B	sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1			0.25		1
18b		5.0	B	sand	CEDE	*Ceratophyllum demersum*	coontail		1	1	4	1.50		1
18b		5.0	B	sand	PORI	*Potamogeton richardsonii*	claspingleaf pondweed		1			0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

18b		5.0	B	sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed				1	0.25		1
18c		5.0	B	sand	LETR	*Lemna trisulca*	star duckweed	2	2	1	1	1.50		0
18c		5.0	B	sand	PORI	*Potamogeton richardsonii*	Richardson's pondweed	1	1		1	0.75		1
18c		5.0	B	sand	VAAM	*Vallisneria americana*	wild celery	1	1	1	1	1.00		1
18d		3.0	B	sand	CHSP	*Chara spp.*	muskgrass	1	1		1	0.75		1
18d		3.0	B	sand	ELSP	*Eleocharis spp.*	spikerush	1	1		1	0.75		3
18d		3.0	B	sand	VAAM	*Vallisneria americana*	wild celery	1	1	1	1	1.00		1
18d		3.0	B	sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1				0.25		1
18d		3.0	B	sand	POIL	*Potamogeton illinoensis*	Illinois pondweed			1	1	0.50		1
18d		3.0	B	sand	LETR	*Lemna trisulca*	star duckweed				1	0.25		0
19	14													
19a		12.0	C	sand	POSP3	*Potamogeton sp.*	narrow leaf pondweed	2	2	3	2	2.25		1
19a		12.0	C	sand	POCR	*Potamogeton crispus*	curlyleaf pondweed	1	1		1	0.75		1
19b		8.0	C	sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1			0.50		1
19b		8.0	C	sand	VAAM	*Vallisneria americana*	wild celery	1	1		1	0.75		1
19b		8.0	C	sand	POSP3	*Potamogeton sp.*	narrow leaf pondweed	1	1		1	0.75		1
19b		8.0	C	sand	CEDE	*Ceratophyllum demersum*	coontail			1		0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): **1**=submerged, 2=floating-leaf, 3=emergent

19b		8.0	C	sand	PORO	*Potamogeton robbinsii*	Robbins' pondweed			1		0.25		0
19b		8.0	C	sand	ZODU	*Zosterella dubia*	water stargrass				1	0.25		1
Transect or Point	**MRD**	**Depth (ft)**	**Depth Code**	**Substrate Type**	**Species Code**	**Species (Scientific Name)**	**Species (Common name)**	**Density Rating Cast # 1**	**Density Rating Cast # 2**	**Density Rating Cast # 3**	**Density Rating Cast # 4**	**Average Density**	**Observed (x)**	**Type[1]**
20	14													
20a		11.5	C	muck	CEDE	*Ceratophyllum demersum*	coontail	1	1		1	0.75		1
20a		11.5	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed	1	1	1	1	1.00		1
20a		11.5	C	muck	POSP3	*Potamogeton sp.*	narrow leaf pondweed	1	1	1	2	1.25		1
20a		11.5	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed				1	0.25		1
20b		8.0	C	silt	PORI	*Potamogeton richardsonii*	claspingleaf pondweed	1	2	2		1.25		1
20b		8.0	C	silt	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1			1	0.50		1
20b		8.0	C	silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1			1	0.50		1
20b		8.0	C	silt	CEDE	*Ceratophyllum demersum*	coontail	1	1			0.50		1
20b		8.0	C	silt	POSP3	*Potamogeton sp.*	narrow leaf pondweed	1				0.25		1
20b		8.0	C	silt	ELCA	*Elodea canadensis*	Canada waterweed		1			0.25		1
20b		8.0	C	silt	LETR	*Lemna trisulca*	star duckweed		1	1		0.50		0

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

20b		8.0	C	silt	POCR	*Potamogeton crispus*	curlyleaf pondweed				1	0.25		1
20c		4.5	B	sand,gravel	VAAM	*Vallisneria americana*	wild celery	1	1	1	1	1.00		1
20c		4.5	B	sand,gravel	CEDE	*Ceratophyllum demersum*	coontail		1			0.25		1
20c		4.5	B	sand,gravel	NAFL	*Najas flexilis*	bushy naiad		1			0.25		1
20c		4.5	B	sand,gravel	POCR	*Potamogeton crispus*	curlyleaf pondweed		1	1		0.50		1
20c		4.5	B	sand,gravel	ZODU	*Zosterella dubia*	water stargrass		1		1	0.50		1
20c		4.5	B	sand,gravel	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1		1	0.50		1
20c		4.5	B	sand,gravel	PORI	*Potamogeton richardsonii*	Richardson's pondweed			1	1	0.50		1
20c		4.5	B	sand,gravel	ELCA	*Elodea canadensis*	Canada waterweed				1	0.25		1
21	13-14													
21a		10.0	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed	1	1	2	2	1.50		1
21a		10.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail	1	1	1	1	1.00		1
21a		10.0	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1	2	1.25		0
21a		10.0	C	muck	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1		1	0.50		1
21a		10.0	C	muck	LETR	*Lemna trisulca*	star duckweed	1	1	2		1.00		1
21b		8.0	C	muck	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1			1	0.50		1
21b		8.0	C	muck	CEDE	*Ceratophyllum demersum*	coontail	1		1	3	1.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
21b		8.0	C	muck	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	3	1	1.50		0
21b		8.0	C	muck	POCR	*Potamogeton crispus*	curlyleaf pondweed	1			1	0.50		1
21b		8.0	C	muck	PORI	*Potamogeton richardsonii*	claspingleaf pondweed		1			0.25		1
21b		8.0	C	muck	LETR	*Lemna trisulca*	star duckweed			1		0.25		0
21c		3.5	C	muck	VAAM	*Vallisneria americana*	wild celery	1	1	1	1	1.00		1
21c		3.5	B	sand,silt	LETR	*Lemna trisulca*	star duckweed	1	4	2	1	2.00		0
21c		3.5	B	sand,silt	MYSI	*Myriophyllum sibiricum*	northern watermilfoil		1		1	0.50		1
21c		3.5	B	sand,silt	NUVA	*Nuphar variegata*	spatterdock		1		1	0.50		2
21c		3.5	B	sand,silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed		1			0.25		1
21c		3.5	B	sand,silt	CEDE	*Ceratophyllum demersum*	coontail		1			0.25		1
22	12--13													
22a		9.0	C	sand	CEDE	*Ceratophyllum demersum*	coontail	1	1	2	1	1.25		1
22a		9.0	C	sand	VAAM	*Vallisneria americana*	wild celery	1	1	1		0.75		1
22a		9.0	C	sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1	1	1	1.00		1
22a		9.0	C	sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed			1	1	0.50		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

22a		9.0	C	sand	ELCA	*Elodea canadensis*	Canada waterweed				1	0.25		1
22a		9.0	C	sand	ZODU	*Zosterella dubia*	water stargrass				1	0.25		1
22b		6.0	C	muck,sand	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1			1	0.50		1
22b		6.0	C	muck,sand	MYSI	*Myriophyllum sibiricum*	northern watermilfoil	1	1	1	1	1.00		1
22b		6.0	C	muck,sand	VAAM	*Vallisneria americana*	wild celery	1	1	1		0.75		1
22b		6.0	C	muck,sand	CEDE	*Ceratophyllum demersum*	coontail		1	1		0.50		1
22b		6.0	C	muck,sand	ZODU	*Zosterella dubia*	water stargrass		1	1	1	0.75		1
22b		6.0	C	muck,sand	ELCA	*Elodea canadensis*	Canada waterweed				1	0.25		1
23	11--12													
23a		6.0	C	sand,silt	PORI	*Potamogeton richardsonii*	Richardson's pondweed	1	1	1		0.75		1
23a		6.0	C	sand,silt	POAM	*Potamogeton amplifolius*	largeleaf pondweed	1	1	2	3	1.75		1
23a		6.0	C	sand,silt	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1		1	1	0.75		0
23a		6.0	C	sand,silt	CEDE	*Ceratophyllum demersum*	coontail	1	1			0.50		1
23a		6.0	C	sand,silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1	1			0.50		1
23a		6.0	C	sand,silt	ZODU	*Zosterella dubia*	water stargrass			1		0.25		1
23a		6.0	C	sand,silt	ELCA	*Elodea canadensis*	Canada waterweed			1		0.25		1
23b		3.0	B	sand,silt	VAAM	*Vallisneria americana*	wild celery	1				0.25		1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake June 23 and 24, 2005

Transect or Point	MRD	Depth (ft)	Depth Code	Substrate Type	Species Code	Species (Scientific Name)	Species (Common name)	Density Rating Cast # 1	Density Rating Cast # 2	Density Rating Cast # 3	Density Rating Cast # 4	Average Density	Observed (x)	Type[1]
23b		3.0	B	sand,silt	PORO	*Potamogeton robbinsii*	Robbins' pondweed	2	1	2	3	2.00		0
23b		3.0	B	sand,silt	POAM	*Potamogeton amplifolius*	largeleaf pondweed		1			0.25		1
23b		3.0	B	sand,silt	PORI	*Potamogeton richardsonii*	Richardson's pondweed		1	1		0.50		1
23b		3.0	B	sand,silt	NUVA	*Nuphar variegata*	spatterdock					0.00	X	2
23b		3.0	B	sand,silt	ZODU	*Zosterella dubia*	water stargrass			1	1	0.50		1
23b		3.0	B	sand,silt	CEDE	*Ceratophyllum demersum*	coontail			1		0.25		1
23b		3.0	B	sand,silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed			1		0.25		1
23b		3.0	B	sand,silt	MYSI	*Myriophyllum sibiricum*	northern watermilfoil				1	0.25		1
23b		3.0	B	sand,silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed					0.00	X	1
23c		2.0	B	sand,silt	LETR	*Lemna trisulca*	star duckweed	1	2		1	1.00		0
23c		2.0	B	sand,silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed	1			1	0.50		1
23c		2.0	B	sand,silt	CEDE	*Ceratophyllum demersum*	coontail	1		1	1	0.75		1
23c		2.0	B	sand,silt	PORO	*Potamogeton robbinsii*	Robbins' pondweed	1	1	1		0.75		0
23c		2.0	B	sand,silt	NUVA	*Nuphar variegata*	spatterdock	1				0.25		2
23c		2.0	B	sand,silt	POZO	*Potamogeton zosteriformis*	flatstem pondweed					0.00	X	1

Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

Balsam Lake **June 23 and 24, 2005**

23c		2.0	B	sand,silt	POAM	*Potamogeton amplifolius*	largeleaf pondweed				1	0.25		1
23c		2.0	B	sand,silt	ZODU	*Zosterella dubia*	water stargrass		1	1	1	0.75		1

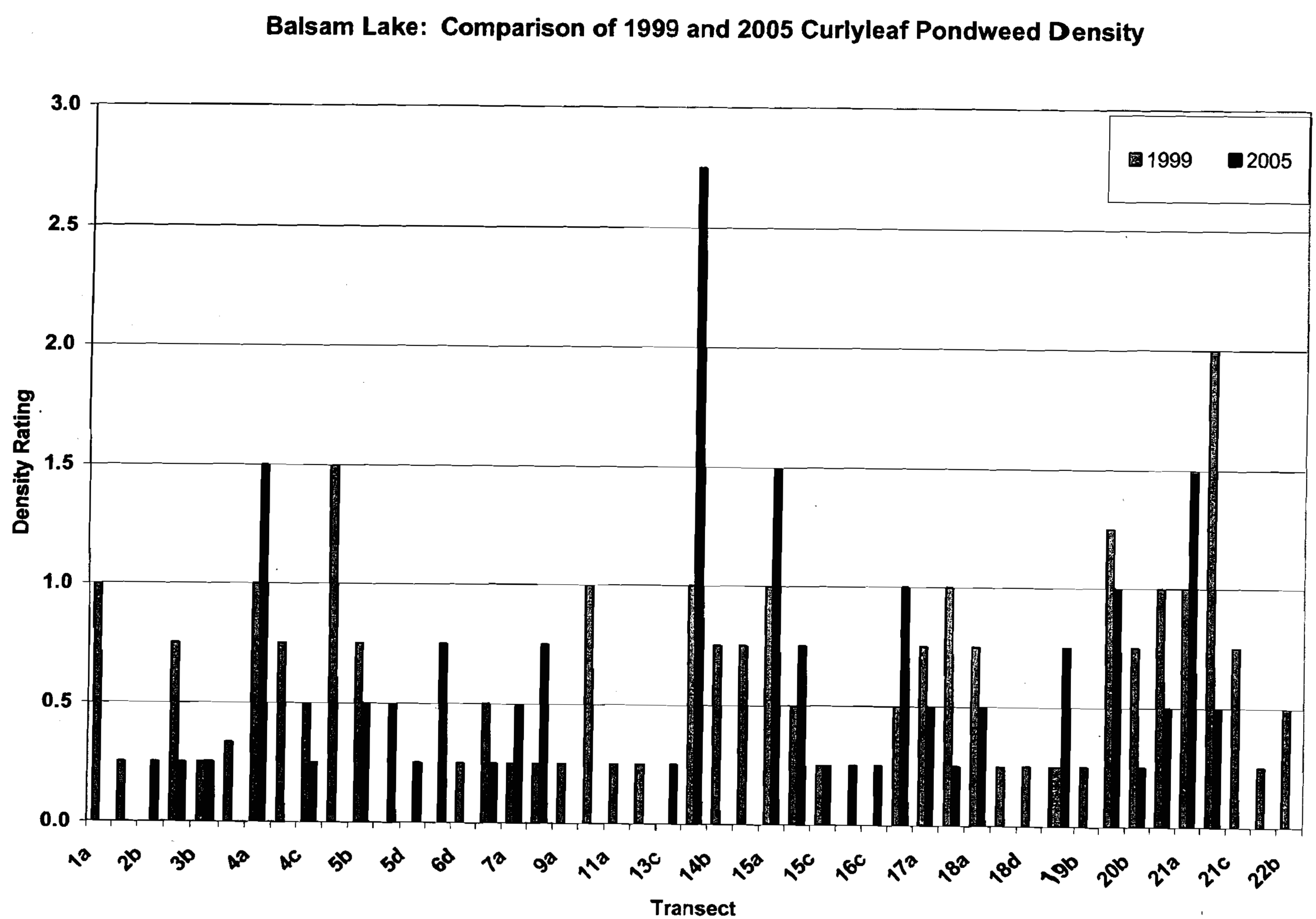
Depth Categories: A. 0' to 1.5'
B. 1.5' to 5.0'
C.5.0' to 10.0'

[1]Type (plant community): 1=submerged, 2=floating-leaf, 3=emergent

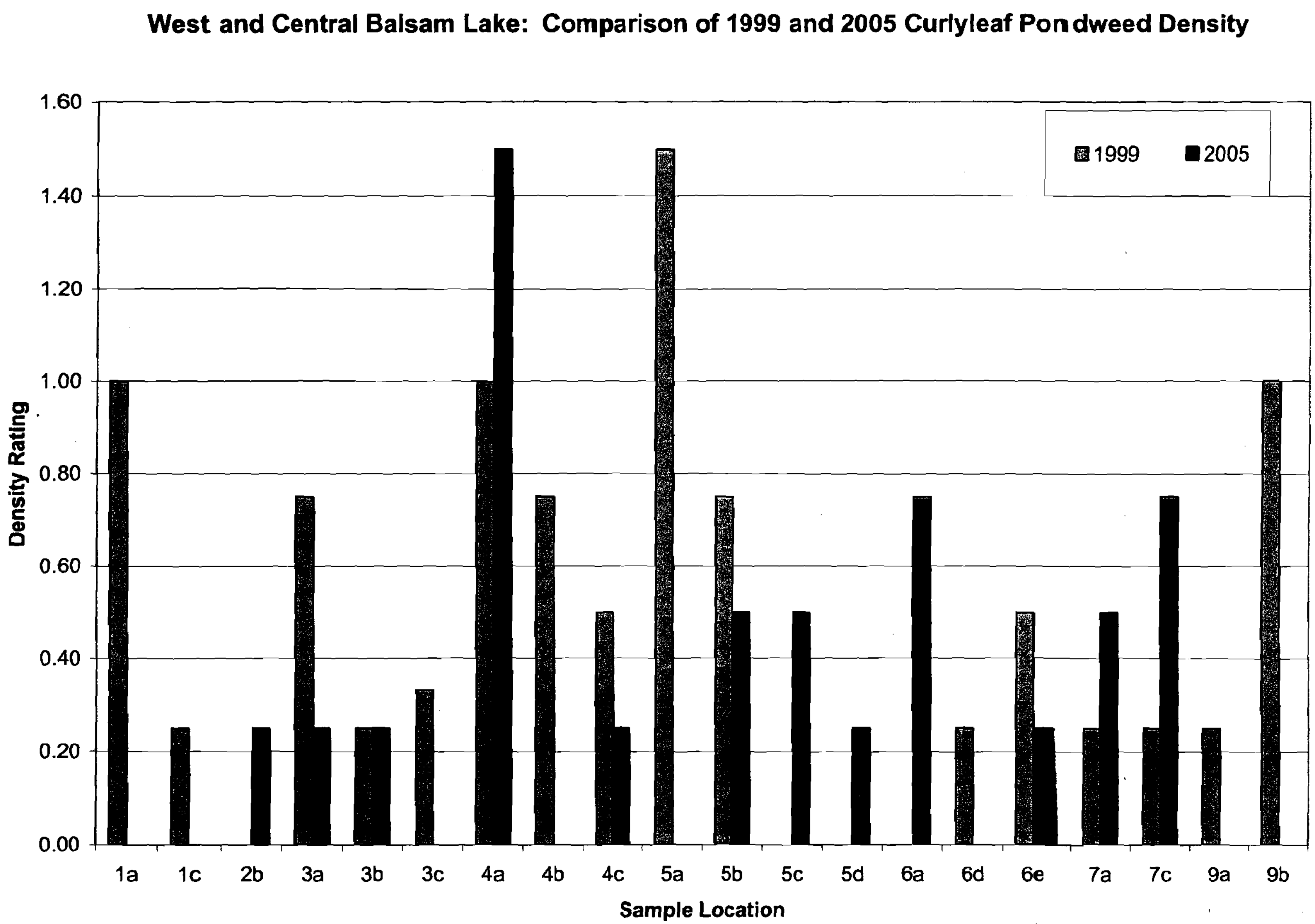
Balsam Lake
June 23 and 24, 2005

Transect or Point	Depth (ft)	Depth Code	Comment
2b	4.5	B	filament algae present
2c	2.0	B	filament algae present
3a	8.0	C	filament algae present
3b	2.5	B	filament algae present
4a	9.0	C	curly-leaf growth visually dense around this point
4c	2.0	B	burweed
5a	3.5	B	algae present
5b	6.0	C	heavy algae
5c	6.5	C	Algae
5d	7.5	C	Algae
6a	4.5	B	Algae
6e	2.5	B	Algae mats
7c	4.5	B	Algae fibrous mass present at all locations
8b	4.0	B	Fibrous Algae 100% each rake cast
8c	2.5	B	Algae present 30% of casts
10c	3.0	B	cattails at shore
19a	12.0	C	Potamogeton sp. (narrow leaf pondweed) is visually dense in 9a area with healthy growth
22a	9.0	C	Algae present
23b	3.0	B	filament algae present
23c	2.0	B	filament algae present

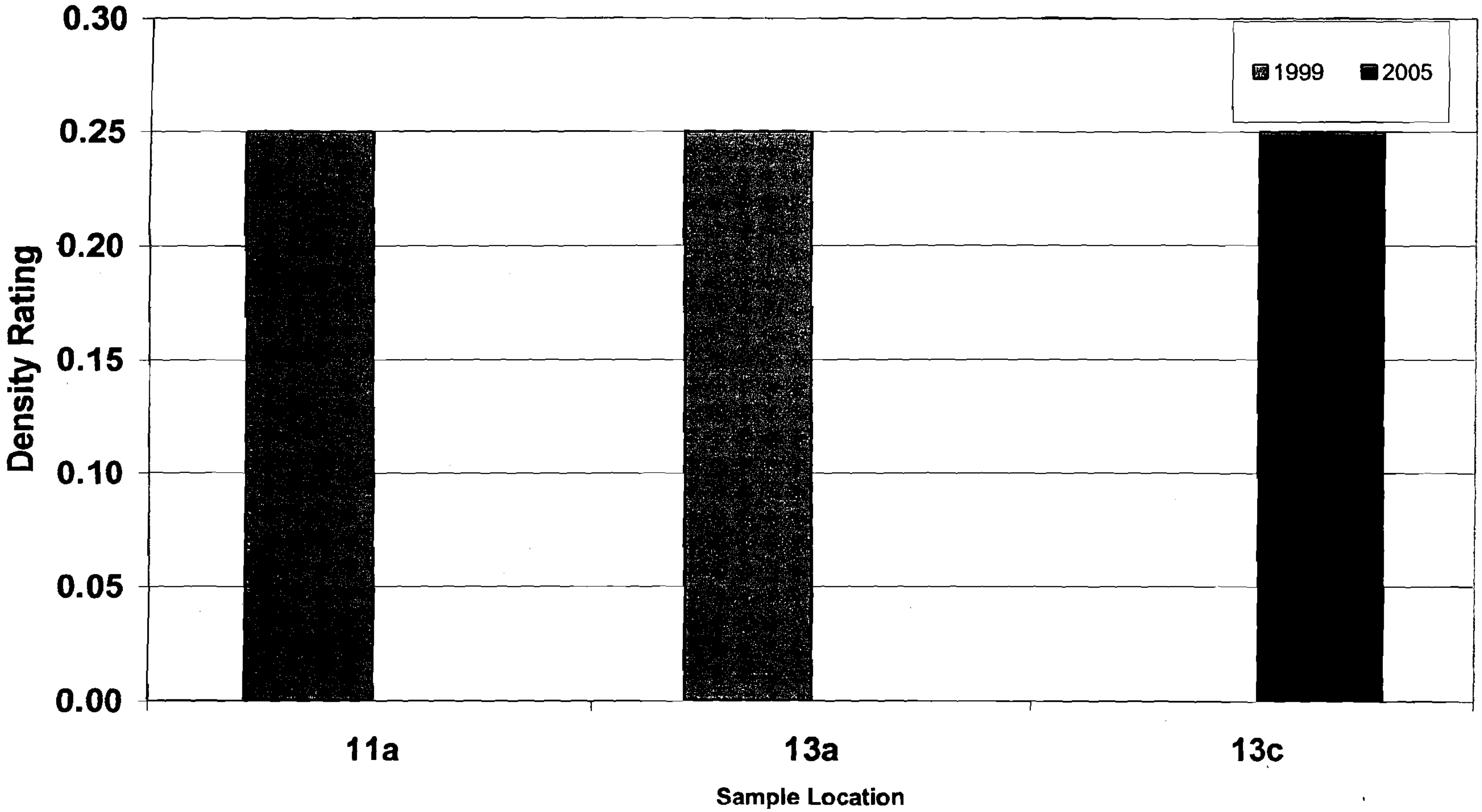
Appendix C
Balsam Lake: Comparison of 1999 and 2005 Curlyleaf Pondweed
Density

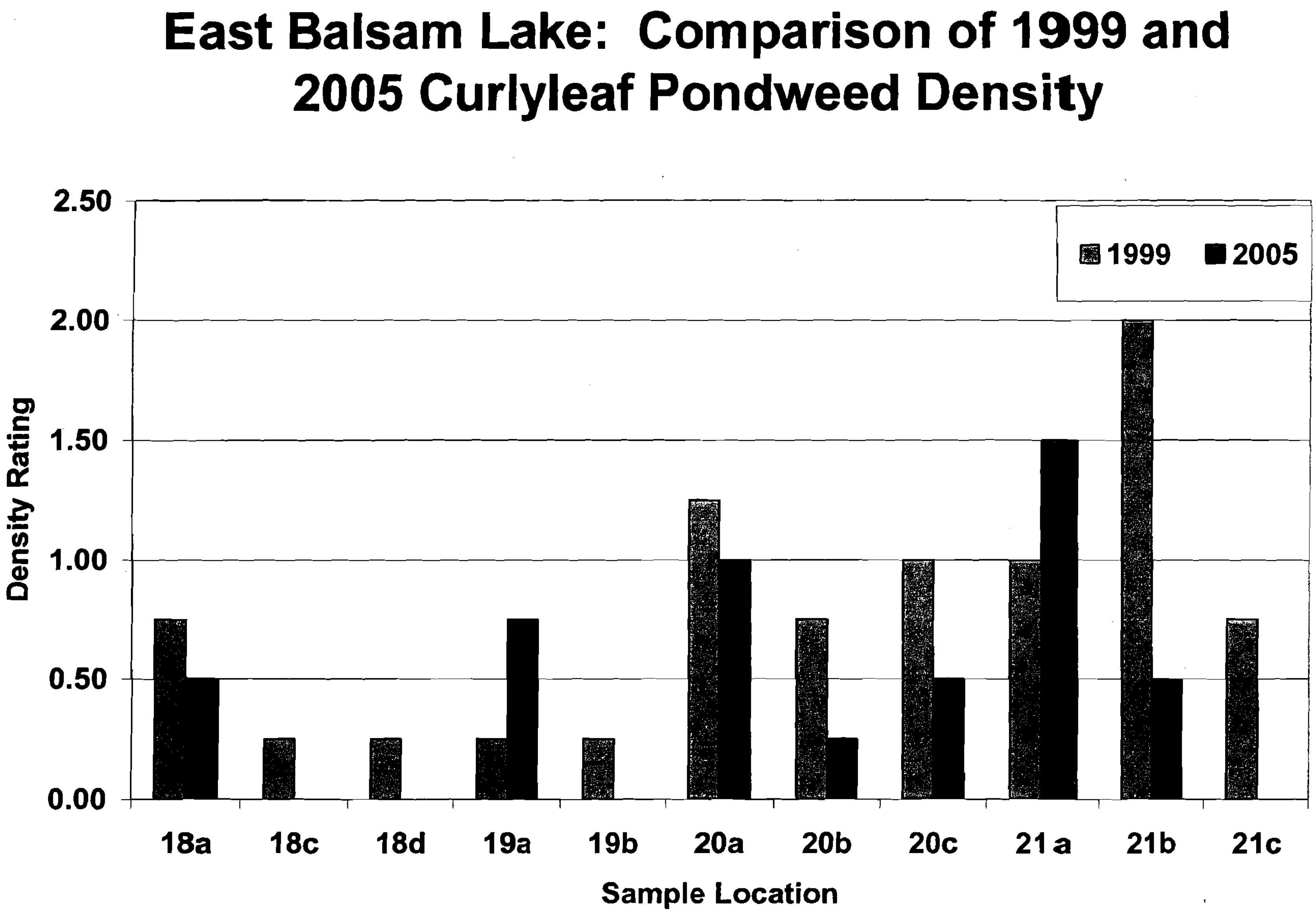


Balsam Lake: Comparison of 1999 and 2005 Curlyleaf Pondweed Density
Density Rating
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1999
2005
1a
2b
3b
4a
4c
5b
5d
6d
7a
9a
11a
13c
14b
15a
15c
16c
17a
18a
18d
19b
20b
21a
21c
22b
Transect


West and Central Balsam Lake: Comparison of 1999 and 2005 Curlyleaf Pondweed Density
1999
2005
Density Rating
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.40
1.60
1a
1c
2b
3a
3b
3c
4a
4b
4c
5a
5b
5c
5d
6a
6d
6e
7a
7c
9a
9b
Sample Location

Little Balsam Lake: Comparison of 1999 and 2005 Curlyleaf Pondweed Density




East Balsam Lake: Comparison of 1999 and 2005 Curlyleaf Pondweed Density
1999
2005
Density Rating
2.50
2.00
1.50
1.00
0.50
0.00
18a
18c
18d
19a
19b
20a
20b
20c
21a
21b
21c
Sample Location